ELECTRICAL WORLD

A consolidation of Electrical World, Electrical Engineer and American Electrician

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What in the World!

Welcome to a new administration. Now we are set for four more years with complete party control. There can be no alibis to action, but we doubt the power of politics to rectify economic forces. The electrical industry has nothing to fear and much to hope for from the new administration despite some wild statements and suggestions. Now, as before, the electrical industry will work out its own destiny and receive the rewards or penalties that it deserves by its actions. Personally, we are not going to bother the new administration or let it bother us.

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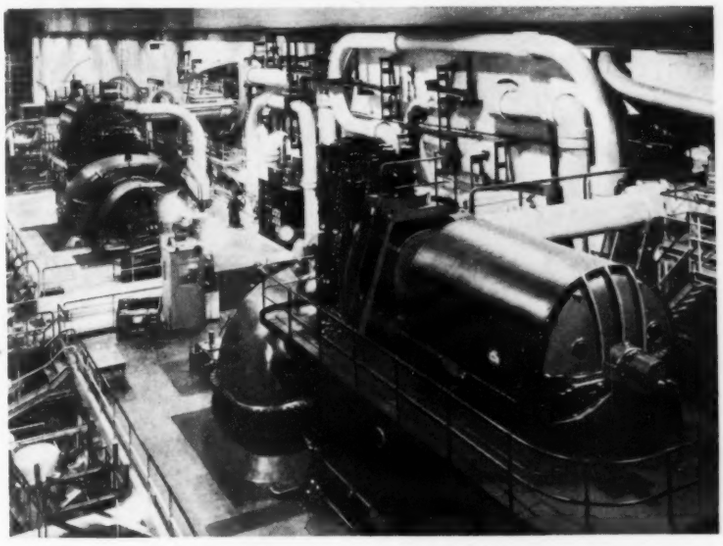
Our desk is cluttered with books, pamphlets and letters purporting to show how national prosperity can be secured. All suggestions are different, all generalize, all miss some of the factors in the equation and all are interesting. They also help the printing, paper, pencil and ink industries. Most of the men with their solutions to national problems have taken time from their daily jobs to develop these theories. We think they would have accomplished more by putting their time and attention toward doing more effective work on their respective jobs.

●

Readers must bear with us if we preach a little these days. We find so much to preach about. Unsold markets, bad morale, inert organizations, opportunities for sales and service, political agitation, industry regulation, rehabilitation and modernization — there are a host of things that afford good texts. We sometimes wish all our pages were editorials, but then, we have sense enough to know that preaching is very ineffective in this hard-boiled and materialistic world. So we try the other approach and give articles that cite facts or we get some leader to preach for us.



Double-deck generators, Pacific Gas & Electric Company

MARCH 4, 1933

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ELECTRICAL WORLD

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for the Week Ending

March 4, 1933

Three Insulls and Associates Indicted for Use of Mails to Defraud

FOLLOWING an investigation of the Insull situation by agents of the Department of Justice, which covered a period of four months and centered largely on the books of Corporation Securities Company, a grand jury in Chicago this week returned the first indictment in the federal investigation, accusing nineteen individuals of a gigantic mail fraud through the selling of Corporation Securities stock. Among those indicted, in addition to Samuel Insull, Sr., Samuel Insull, Jr., and Martin J. Insull, are Stanley Field, nephew of the late Marshall Field; Harold L. Stuart, president of Halsey, Stuart & Company, investment brokers, and Edward J. Doyle, president of the Commonwealth Edison Company. Other defendants include officers or directors of defunct Insull companies.

Non-extraditable charges

Judge Charles E. Woodward ordered each defendant to post a bond of $19,000 and bench warrants for their arrest were placed in the hands of deputy marshals, but after Mr. Field and certain other defendants posted bond he ordered the withdrawal of the bench warrants.

"This indictment is only the beginning," said Federal Attorney Dwight H. Green. "I propose to investigate fully all the ramifications of the so-called Insull empire, its creators and sponsors." The single indictment contains 120 pages with numerous photostatic copies of letters and statements sent through the mails to stockholders and investors, and there are 25 counts alleging use of the mails in a scheme and artifice to defraud. The maximum penalty, upon conviction on any count, is five years' imprisonment and a fine of $10,000.

The indictment does not mention the long-contested pledging of securities, virtually everything in the company's portfolio, for bank loans totaling $15,000,000 in violation of covenants with debenture holders not to pledge such assets without equally securing the debentures. These transactions are still being scrutinized by Prosecutor Green, who is hopeful of obtaining an indictment charging violation of the bankruptcy statutes, on which Samuel Insull, Sr., and Martin J. Insull could be extradited from Greece and Canada, respectively. There is no provision in the treaties for extraditing mail fraud defendants.

> **In simple terms I have attempted to say to the people of this country that the way out of disaster and depression is a battle to be fought by the people; that the task of rebuilding must come from the resolute action of millions of men and women who belong to all parties; but, at the same time, that leadership is essential to provide for their plans of action, and to keep vividly before them the definite objectives.**
>
> FRANKLIN D. ROOSEVELT

The true bill is based on alleged "false pretenses, representations and promises" made to prospective investors in the sale of the company's common stock. The defendants engaged in a nation-wide campaign of selling this stock through Halsey, Stuart & Company, Utility Securities Company, Insull, Son & Company, Corporation Syndicates Company, and others, the indictment charges. It is charged that the defendants represented to investors that they would find a safety of principal on their investment because of the great physical properties of the company, when, in fact, there were no great physical properties and the security back of the common stock was worthless.

Four indicted directors of Corporation Securities issued a statement through their attorney that the government has misapprehended the facts regarding their association with the company. "Our clients," the statement said, "had every confidence in the soundness of Corporation Securities Company, as evidenced by the fact that they themselves invested many hundreds of thousands of dollars of their own money in the same common stock which they are charged with wrongfully selling, and they made these investments not for resale but for permanent investments for the security of themselves and their families . . ." Present indications are that the federal grand jury will remain in session for two more months to investigate the Insull Utility Investments, Inc., the Mississippi Valley Utilities Company and finally the Middle West Utilities Company.

While the grand jury was making plans for the continuation of its work, Sam Howard, trustee in bankruptcy for the Corporation Securities Company, began suit in the United States District Court against the Guaranty Trust Company, Central Hanover Bank & Trust Company and the Chase National Bank to recover blocks of securities which last April, when they were pledged, were worth approximately $360,000, $3,175,000 and $360,000 respectively. The plaintiff alleges that the collateral was posted when the corporation was insolvent, its liabilities, other than capital stock and supposed surplus, aggregating $56,788,234 and its assets not more than $12,153,785.

Directorates reorganized

Reorganizations of the directorates of the Commonwealth Edison Company and the Public Service Company of Northern Illinois have been voted at the annual meetings of shareholders. The board of each company was reduced

from thirteen to nine members and the "Insull" directors were displaced by outsiders not connected with the old management. Six new directors were also elected to the board of the Peoples Gas, Light & Coke Company at the annual meeting. James Simpson, chairman of the former Insull "big three," informed stockholders that the directors had upheld the pensions granted last year to Samuel Insull on his retirement from the companies. Mr. Insull is now receiving $6,000 a year from each of the companies.

Federal Trade inquiry

On resuming its examination February 24 of Insull companies in receivership the Federal Trade Commission was told how the Insulls and Halsey, Stuart & Company by a process of pyramiding their holdings controlled utilities with a small outlay of money. Under questioning by Robert E. Healy, chief counsel of the commission, Judson C. Dickerman, examiner, showed that Insull interests with 0.15 per cent of the securities of Seaboard Public Service Company, or an investment of $49,600, controlled the $33,201,450 company.

The legal struggle over appointment of a trustee in bankruptcy for Insull Utility Investments, Inc., continues, but Federal Judge James H. Wilkerson has taken the matter under advisement and hopes to hand down a decision soon.

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Shannon River Project Encounters Obstacles

Following the shift in 1931 when the River Shannon scheme of the Irish Free State was removed from its original status and the whole project made subservient to the Ministries of Industry and Commerce and of Finance, the power development has, according to English observers, fallen into notable stagnation and increasing difficulties.

Recent increases in fixed charge portions of the rates charged domestic consumers have ranged from 10 to 25 per cent and the enterprise operates at a deficit even though all sinking fund provisions be omitted from current statements.

"The Irish Free State," according to our contemporary the *Electrical Review* (England), "tried to run its finely conceived national supply program without an electrical engineer on the board for rather less than two years and the result has not been encouraging. The present situation seems to be that the board cannot carry out the smallest extension without obtaining the specific sanction of two ministers of state, which means, of course, a series of permanent civil servants who have not the necessary experience to express an opinion either upon technical matters or questions of supply economics."

North American Earned $2.01 a Share in 1932

Year Ended December 31. (Consolidated Statement)

		Compared with 1931 per Cent
Income		
Net operating income....	$50,692,201	— 8.1
Non-operating income.....	6,918,816	—13.4
Investment account profit.	— 4,030	($471,431)
Holding company expenses	260,044	—32.8
Interest, subsidiary dividends and minority interest.....	26,501,048	+ 4.2
Depreciation.....	14,430,144	+ 6.8
Balance available for dividends.....	16,415,750	—47.8
Balance to surplus.....	— 1,236,950	($977,081)
Balance Sheet		
Property and plant.....	$675,534,544	+ 0.7
Investments*.....	140,321,278	Negl. change
Current assets.....	53 504 639	+23.6
Current liabilities.....	7,706,641	—60.0

* Estimated market value of listed securities December 31, 1932, $93,705,670; book value $131,955,312.

▼

20,000-Ton Passenger Ship Completely Electrified

Said to be one of the most completely electrified ships in the world, the new Furness liner *Queen of Bermuda* has arrived in New York to enter the short-run service to the Bermudas. Electrical energy will be used for propulsion, auxiliary services, cooking, lighting, etc.

Two 7,500-kw. turbo-generators supply energy for the operation of four 4,750-hp. synchronous motors direct-connected to each of the main propeller shafts. Four 750-kw. auxiliary generators supply energy for power, light and heat. Electric motors, the largest of which are rated at 160 hp., total 5,000 hp. Maximum load required for cooking 620 kw. Representative lighting loads are 39.5 kw. in the first-class dining saloon and 54.4 kw. for mobile color lighting in the dance hall. Two refrigerating plants with a total of 23 motors have been installed. The total of energy generating and utilizing equipment is thus 35,000 to 40,000 kw.

Propulsion motors have salient poles with heavy damping windings in their faces to develop a high torque on reversal. In starting, the turbines are run up to one-fifth speed and the fields of the alternators are then overexcited; the motors run up to speed as induction machines when their fields are switched on and they pull into step; the alternator fields are reduced to normal and the alternators' speeds can be varied from one-fifth to full load.

▼

The First Electric Light?

That the first man-made device producing electric light may have functioned nearly 400 years ago was the heuristic titbit tossed to a meeting of the American Society of Mechanical Engineers in New York this week by Orestes H. Caldwell, editor of *Electronics*. Mr. Caldwell pointed to the discharge of static electricity in the vacuum above the mercury in a ship's barometer agitated in stormy weather, producing a glow discharge, as a phenomenon discussed in the early 1700's and presumably observed by mariners soon after the introduction of this type of instrument.

▼

Virginia Rate Probe May Avoid Revaluation

Intimations that revaluation of the properties of the three largest electric utilities in Virginia may not be made in connection with the state Corporation Commission's survey of the rate situation there were offered by Allen J. Saville, engineer directing the survey, as the hearings opened last week.

It is said that the inquiry (ELECTRICAL WORLD, February 4, page 148) will not require more than a year, possibly not more than six months. Copies of the accounts of the three companies, Virginia Electric & Power, Virginia Public Service and Appalachian Electric Power, for the past five years will be submitted to the director of the survey shortly.

Power company officials at the opening hearing were told by Mr. Saville that his task was to seek the "simplest, quickest way to ascertain the facts, analyze those facts and report to the state Corporation Commission, which fixes rates." Full co-operation has been promised by utility executives.

▼

Missouri Penalties Under Fire

Investigation of the reasonableness of the penalties and discounts allowed on the electric service bills of the Union Electric Light & Power Company and Kansas City Power & Light Company is being undertaken by the Missouri Public Service Commission upon complaints filed with that body. It is alleged that dissimilar practices are followed for various cities served.

▼

Stone & Webster 1932 Report

Consolidated net income of Stone & Webster, Inc., as shown in the annual report for 1932, just issued, amounted to $1,524,085 after charges, taxes and depreciation, equal to 72 cents a share earned on 2,104,500 shares of stock, without including net profit on sales of securities during the year. This compares with $3,291,785, or $1.56 a share, earned in 1931, excluding losses on the sale of certain securities acquired in prior years. Gross earnings amounted to $50,983,871, compared with $59,522,087, a decline of 14 per cent, and operating expenses were $23,686,872, against $29,904,041, a decrease of 20 per cent.

General Electric Earnings Fell Short of Dividends

For the year ended December 31, 1932, the General Electric Company reports, after payment of dividends, a deficit from the year's operations of $4,035,080, as compared with $7,768,266 for 1931, according to information contained in a summary of the annual report which will be distributed to stockholders later.

Sales billed were $147,162,291 in 1932, compared with $263,275,255 in 1931. Profit available for dividends for 1932 was $14,404,110 and, after providing for dividends of 6 per cent on the special stock, there remained available for common $11,829,078, or 41 cents per share. This compared with $38,381,990, or $1.33 per share, in 1931. Dividends on common stock declared during 1932 amounted to $15,864,157.

Current assets at the end of the year were $179,888,465, of which $118,608,017 was cash and marketable securities. A year ago current assets amounted to $219,086,511, of which $122,178,933 was cash and marketable securities. Current assets were 10.9 times current liabilities in 1932, compared with 7.7 times in 1931. Manufacturing plant has been further written down from $46,061,019 to $44,789,520.

Radio Corporation stock distributed as a dividend to General Electric stockholders on February 20, 1933, valued at $26,440,265, was removed from investments and charged to surplus. The investments in associated companies and miscellaneous securities at market, or fair value amounted to $153,579,518. The decrease resulting from revaluation, amounting to $19,498,310, was charged to surplus.

▼

Senate Increases Funds for Trade Commission

Funds for the Federal Trade Commission during the next fiscal year were more than doubled by the Senate over the amount appropriated by the House, as the independent offices appropriation bill was considered last week by the Senate. The action, taken on a motion by Senator Robinson of Arkansas, minority leader, raised the total available for the commission from $510,000 as it passed the House to $1,181,500. This sum represents an increase of approximately $300,000 over the amount of the increase which the Senate committee on appropriations had recommended. As the bill was submitted by the committee, there was an increase of $280,000 over the House appropriation and a provision that the entire amount of the increase should be available for completion of the public utilities investigation.

Needed — a Good Spring Tonic

Badly demoralized though markets and general business feeling may have become, largely due to the unfortunate outbreak of discouragement after the Michigan bank moratorium, the next few weeks hold virtually unparalleled psychological and dramatic possibilities, and Mr. Roosevelt is probably far too astute a man of public life to neglect them.

Behind the years-old news of confidence-wrecking shortcomings in high financial circles and the fact of banking moratoriums in fifteen states lies the story of the pulse and life of trade. That the activities of industrial and commercial enterprise are not without notable strength at this time is the evidence that electrical energy output shows real resistance to depressing developments. Bituminous coal production is 27 per cent over that early in February. Carloadings have risen fairly precipitously for three consecutive weeks and in a manner wholly unrelated to last year's performance. Commodity prices, while weak, have not receded to the levels of early February.

Virtually every one of the many witnesses called before the Senate subcommittee on finance has told the same story—sound money and a balanced budget constitute the one way out, though it may be a painful one.

That the morale of the nation would be greatly strengthened by definite assurance that the incoming administration will back sound currency, and better banking, drastically curtailed governmental expenditures (including loosening the veterans' throttle-hold) and agreements in the international situation that will lead to settlements and economic discussions and action is as likely as the probability that Mr. Roosevelt will sponsor them all.

Public disappointment that no master minds appear in the new Cabinet should be short-lived—if for no better reason than that there are no longer any of those fabulous supermen. It is to whatever innate common sense and hard-headed-willingness that there may be among us to fight through to a finish by the work of the ordinary man that we must look. The new Cabinet appears to be conservative and non-panicky. Don't be surprised to be surprised in March.

During the week the Federal Trade Commission sent to the Senate its interim report of progress on its investigation of power and gas utilities, listing twelve large power and gas utility groups with their subsidiaries concerning which reports are now being prepared or of which field examinations are being made.

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1,200-Ton Cargo Vessel of All-Welded Construction

All-welded construction has been employed in the 1,200-ton steel cargo ship *William F. Kenny*, fabricated for the New Jersey Clay Products Company and launched this week. Built on a patented reverse channel system, devised to reduce the gross hull weight by the elimination of ribs, an increased carrying capacity of the vessel was achieved coincident with reduced cost and time of construction. This system involves the welding of 12-in., 60-ft. steel channels into complete hull sections, which are then lifted into place and supported by transverse stringers.

The welded method of construction gives the ship the appearance of corrugation and eliminates all the usual riveting. The vessel is 185 ft. in length, of 43-ft. beam and 9.5-ft. draft and has a displacement tonnage of 1,200.

Unusual equipment includes a traveling crane which enables a crew of seven to load, transport and unload a cargo of 1,200 tons of hollow tile packed in cases of 2 tons each.

California Tax Board Backs Recommendations

Standing firmly by the contentions expressed by it several months ago (ELECTRICAL WORLD, December 17, 1932, page 808) that about $5,800,000 a year could be added to the income of the state were the utilities taxed upon a different basis, the California State Board of Equalization has through one of its members, F. E. Stewart of the State Tax Research Bureau, denounced as "a deliberate attempt to mislead the public" the claim that readjustment of taxes by the Legislature means an inevitable increase in gas and electric rates.

Tax inequalities seen

"Gas and electric companies now are paying but $1.24 on the $100 value of their properties, while the average home owner in California pays $1.85 on the $100," said Mr. Stewart.

"While we are advocating an increase of approximately 50 per cent in gas and electric utility taxes we must remember that no tax equalization for this group has been made for twelve years, while during this period the tax rate on common property has increased steadily."

It is said that the Tax Research Bureau has compiled statistics in an endeavor to show that the gas and electric utilities can pay substantially more than their present taxes and still receive the return of 7 per cent allowed them on their investment through state regulation of their rates, but details are not available.

Coming Meetings

Oklahoma Utilities Association—Oklahoma City, Okla., March 7-8. E. F. McKay, 1020 Petroleum Bldg., Oklahoma City, Okla.

National Sales Section, N.E.L.A.—Committee meetings, Chicago, March 21-23. A. J. Marshall, 420 Lexington Ave., New York.

National Engineering Section, N.E.L.A.—Committee meeting, Detroit, Mich., April 3-7. A. J. Marshall, 420 Lexington Ave., New York.

Maryland Utilities Association—Baltimore, Md., April 21. D. E. Kinnear, 803 Court Square Bldg., Baltimore, Md.

Missouri Association of Public Utilities—Excelsior Springs, Mo., April 27-29. N. R. Beagle, 101 West High Street, Jefferson City, Mo.

American Institute of Electrical Engineers—District meeting, Schenectady, N. Y., May 10-12. H. H. Henline, 33 West 39th St., New York.

Electrochemical Society — Montreal, Que., May 11-13. Colin G. Fink, Columbia University, New York.

National Fire Protection Association—Milwaukee, Wis., May 29-June 1. A. R. Small, 109 Leonard St., New York.

▼

Pennsylvania Chairman Sees No Need for Probe

Strange and inscrutable peace has descended upon the Commonwealth of Pennsylvania, where not so long ago the strident charges of Governor Pinchot formed a diatribe of hate against the utilities. The Governor has ceased his ranting and Clyde L. King, chairman of the Public Service Commission, of whom Governor Pinchot said, in appointing him and the other members of the commission, ". . . I have selected men who hold the same views on public utilities that I do" (ELECTRICAL WORLD, September 17, 1932, page 355), concedes that times have changed.

"I think facts and present conditions are changing so fast that historical facts have little to do with what we can accomplish," said Dr. King, thereby paving the way for an early termination of the Pennsylvania Senate investigation of the former utility commission and of regulation within the state.

Testifying at a public hearing before the investigating committee, Dr. King said further that he knows nothing the committee does not have and should have in its study of changes in the public service commission law and that he knows nothing the committee should know about the conduct of any present member of the commission.

Commission opposes reform bill

He told the committee that "honest and prudent investment" instead of reproduction cost new, less depreciation, should be the basis of utility rates. An appropriation of $1,200,000 was cited by him as the best aid that could be given the cause of adequate regulation in Pennsylvania.

At the start of the hearing Dr. King read a statement representing the unanimous opinion of the commission regarding the McClure omnibus bill amending the public service commission law (ELECTRICAL WORLD, February 25, page 245). The commission opposed the creation of the people's counsel bureau for four reasons: the plan would encourage litigation without assurance of results that cannot be more surely achieved through existing channels; the plan would place a large number of new cases on the already overcrowded commission calendar; the plan would ruin the work of the commission because it gave the people's counsel power to obtain the aid of commission engineers and accountants; the plan does not get to the heart of the trouble, as most communities already have attorneys of their own.

The statement said the commission approved the proviso which would give the commission power to suspend rate increases before they become effective. The provision giving the commission greater power over utility securities also was approved but the commission said it would have certain amendments to this section to suggest later. Other recommendations for changes in the proposed law will be made later, the commission said.

Dr. King pointed out that utilities have only an apparent monopoly in their field, and that they receive competition today from an economic standpoint. Utility earnings today, he said, are at the lowest point at any time since the World War. Some utilities, he said, are cutting rates despite the fact that they are not earning a fair return.

Six-State Conference on Interstate Regulation

Reliance upon the co-operative activities of existing state regulatory bodies rather than upon federal agencies is the probable tenor of the agreements to be drawn by the states acting with New York upon the problem of the regulation of interstate power.

At the second meeting of the New York State Commission on Interstate Transmission of Power (ELECTRICAL WORLD, February 11, page 181), held in New York City last week, representatives of Massachusetts, Pennsylvania, Connecticut, New Jersey, Vermont and New York discussed the problem and intimated that the "existing gap in utility regulation" would be bridged by the plans under consideration.

Agreements being formulated

"Compacts or agreements to which the various adjoining states would become parties are being formulated and will be the subject of further study and discussion on the part of the states which are now pioneering in this matter," said the announcement following the meeting. "It was suggested that states other than those above mentioned might be desirous of becoming parties to similar agreements."

The fact that interstate agreement on a "comprehensive plan for supervising rates for electricity and gas transferred across state lines" would relieve the federal government of exercising its interstate commerce powers was stressed.

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Legislators Study Many New Bills

NEW measures relating to public utility regulation, merchandising, taxation, etc., have been presented to the legislators of the various states in addition to those previously reported (ELECTRICAL WORLD, February 11, page 180; February 18, page 212, and February 25, page 244). Among the more important of the new bills are the following:

ARKANSAS—Would create a fact-finding tribunal in the Corporation Commission to investigate the rates of utilities and assist municipalities in handling rate matters.

COLORADO—Would impose state tax on gross income of electric, gas and telephone companies.

INDIANA—Would bar utility appeals to federal court in rate cases by settling appeals in state superior courts.

MASSACHUSETTS—Would provide for more easy establishment of municipal plants.

MICHIGAN—Would empower municipalities to issue and sell revenue bonds based for security on earnings of public utilities, enabling flotation of bonds totaling approximately $60,000,000 for needed public projects.

MISSOURI — Would grant perpetual franchises for public utilities operating in the state, except telephone companies. Would give the Public Service Commission greater control over holding companies of public utility companies operating in the state. Would permit towns and cities to apply to Reconstruction Finance Corporation for loans to finance construction of municipal light and power plants.

NEW JERSEY—Would give Public Utilities Commission greater control over expenditures of public utility operating companies, particularly those for stocks, bonds and other securities.

NEW YORK—Would amend public service law to charge to public utilities all fees and costs of proceedings before Public Service Commission. Would amend the county law to empower board of supervisors of any county to assign to county attorney duty of representing people and guarding their interest with

respect to rates, services and equipment of public utility, railroad, railway and transportation companies operating in and through the county in any proceeding before Public Service Commission. Would authorize board of supervisors to appropriate moneys to pay for expenses incurred in this connection by county attorneys for counsel fees, appraisals, reports, etc. Would permit electric corporations to require every person to whom service is supplied to deposit a reasonable sum of money according to estimated quantity of electricity necessary for two calendar months, to secure payment for electricity consumed or for rent of wire or fixtures, but would allow every such depositor legal interest on sum deposited.

OKLAHOMA—Would require public utilities to leave carbon copies of meter readings with consumer at time of reading.

OREGON—Would authorize municipalities to collect a 5 per cent gross earning tax from private utilities operating without a franchise after a period of 30 days following expiration of contract previously granted.

TEXAS—Would authorize regulation of electric light and power utilities by Railroad Commission. Would prohibit electric and gas companies from engaging in merchandising electric and gas appliances. Would create office of state electrical inspector.

WASHINGTON—Would probibit imposing of taxes on waterworks or power plants owned by cities for maintenance or operation, but authorizing such charges to be paid from earnings.

WISCONSIN—Would prohibit public utilities from merchandising electrical appliances. Would put electric taxes into old age assistance funds and impose a new tax of 5 mills per kilowatt-hour on energy generated or sold.

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No New Utility Financing Undertaken in February

Highly unfavorable conditions, which at the present time prevail in the securities market, offered so little inducement for companies to undertake new financing that not one electric light and power company undertook to float a new issue during the month of February.

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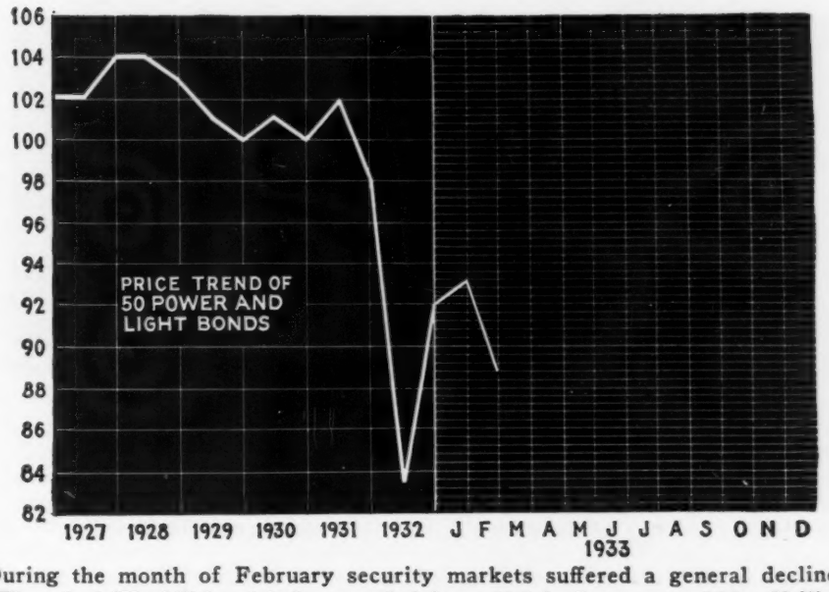
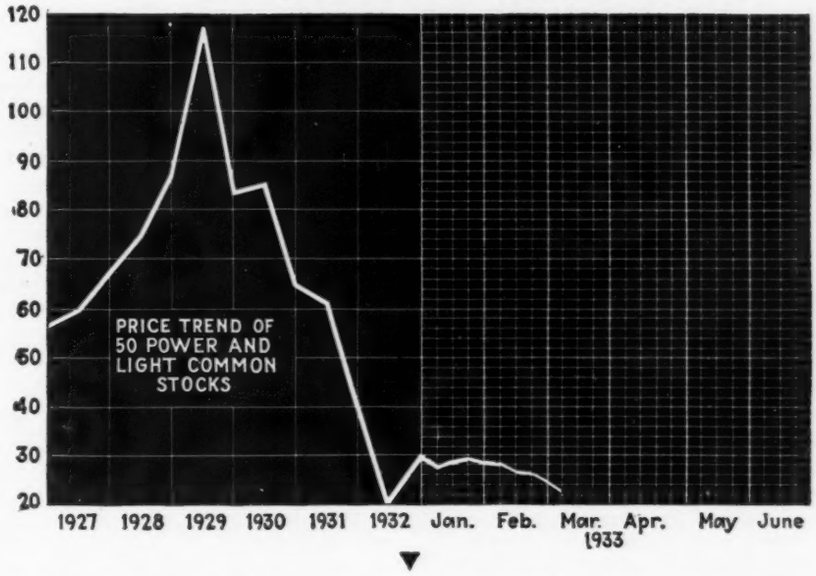
Electrical Exports Decline

As reported by the Bureau of Foreign and Domestic Commerce, exports of electrical products continue to decline. Electrical machinery exports in January of this year totaled $3,085,903, last year $3,641,042, last December $3,193,175. Power generating machinery exports in the same months were $220,538, $471,011 and $300,626 respectively.

Bonds and Stocks Lose Ground



During the month of February security markets suffered a general decline. "Electrical World" bond index receded from 93.5 in January to 88.9. Utility stocks continue weak. "Electrical World" index has dropped to 22.9, the lowest point recorded since last July.



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Public Service of No. Illinois*

(Year ended Dec. 31, 1932)

Earnings

Gross earnings	$34,894,996
Net earnings	$11,273,566
Operating ratio	68
Depreciation allowance	$3,529,095
	10.1% of gross earnings
	0.9% of plant investment
Times prior charges earned	1.6
Net balance per share of common	$5.70
Dividends declared on common	$3,257,387

Output

Energy sales, kw.-hr.	1,162,175,589
Average use per customer, kw.-hr.	2,803†

Balance Sheet

Total assets	$245,522,547
Funded debt	$130,859,000
Capitalization	$212,240,600
Total surpluses plus reserves	$17,837,446
Ratio current assets to current liabilities	1.7

*Includes Public Service Subsidiary Corporation.

†Number of customers based on bills, not meters.

New York Edison Reports

(Year ended Dec. 31, 1932)

Earnings

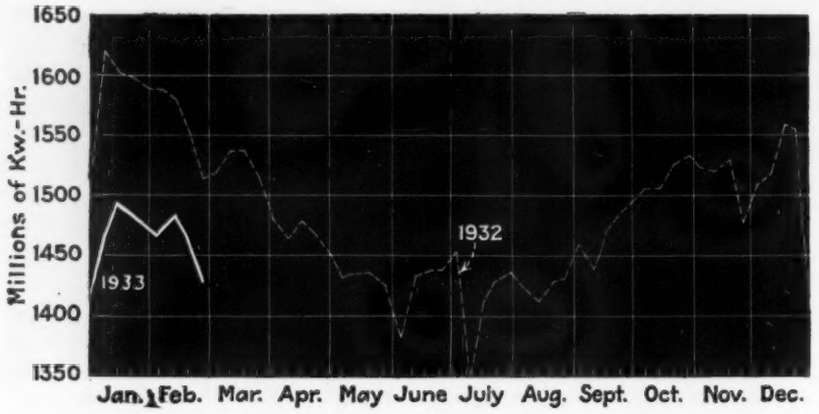
Gross earnings	$70,106,090
	9.2% below 1931
Net earnings	$20,589,983
	21.1% below 1931
Operating ratio	71, against 66 in 1931
Depreciation allowance	$2,896,498
	4.1% of gross earnings
	0.9% of plant investment
Times prior charges earned	5.2
	in 1931, 6.8
Net balance per share of common	$4.93
	in 1931, $5.85
Dividends declared on common	$26,569,985
	in 1931, $31,541,991

Output	Compared with 1931 per cent
Energy sales, kw.-hr. 1,754,913,647	—7.2

Balance Sheet

Total assets $494,865,660	+4.8
Funded debt $124,350,512	+25.1
Capitalization $390,050,362	+6.8
Total surpluses plus reserves $ 93,826,632	—2.3
Ratio current assets to current liabilities	11.2
	in 1931, 13.0

Holiday Cuts Week's Energy Output



Electrical energy production of central electric light and power stations underwent the usual decrease on account of the holiday in the week ended February 25, according to statistics announced by the liquidating committee of the National Electric Light Association. The output, 1,425,511,000 kw.-hr., was down about 44,000,000 kw.-hr. from the preceding week—somewhat more than in 1932 but less than in 1931.

Compared with the corresponding week a year ago the deficiency stands at 5.7 per cent, which is the best showing since early 1932 with the exception of the preceding week and much better than last summer when it ranged around 13 per cent for several months.

In the central industrial area the disparity rose from 6.9 to 9.4 per cent; on the Pacific Coast it fell from 7.0 to 5.4 per cent; changes in the East were small.

Weekly Output, Millions of Kw.-Hr.

Week Ended	1933	1932	1931	1930
February 25....	1,426	1,512	1,633	1,744
February 18....	1,470	1,545	1,680	1,746
February 11....	1,483	1,579	1,684	1,770
February 4....	1,455	1,589	1,679	1,782
January 28.....	1,470	1,589	1,687	1,809

Per Cent Change from Previous Years

Region	Week Ended Feb. 25	Feb. 18	Feb. 11
Atlantic Seaboard.....	— 4.1	— 4.6	— 4.2
New England alone..	— 5.5	— 5.1	— 5.7
Central industrial.....	— 9.4	— 6.9	— 6.5
Pacific Coast.....	— 5.4	— 7.0	— 8.4
United States.....	— 5.7	— 4.9	— 6.1

▼

Electricity Tax Decision Reversed by Treasury

Modifying its decision that electrical energy furnished to an industrial plant during a period when its industrial activities have temporarily or permanently ceased is subject to the tax imposed by the revenue act of 1932, the U. S. Treasury Department has issued a new ruling. This states that electrical energy furnished at such a period of time for the purpose of maintaining the plant in an operating condition, or for protective purposes during its inoperative period, there being no effort to change the nature of the business, is not subject to the tax.

Evidence was submitted to show that the old ruling operates to exempt an industrial consumer from the tax during full-time operation, but subjects the same consumer to the tax when the same operations are curtailed by business or seasonable conditions. The department is now of the opinion that where a user of electrical energy established its predominant character as an industrial consumer and its right to exemption from the tax, this exemption will remain in effect until such time as the character of the operations changes from industrial to commercial, irrespective of whether the plant is operating at full time or part time or is temporarily closed. However, electrical energy furnished to an industrial plant during a period when all of its industrial activities have been permanently discontinued and the property is used for commercial purposes or is held for future sale is subject to the tax.

▼

City Plant Must Be as Voted

City officials of Cushing, Okla., were without authority to issue an $85,000 series of bonds for the purpose "of constructing an electric light equipment, distribution and transmission lines and furnishing electric current to the city," when the voters had authorized a $300,000 issue for the purpose of "constructing an electric plant, distribution and transmission lines and furnishing electric current to the city," the Supreme Court held recently in refusing to grant a writ of mandamus directing the Attorney-General to approve the smaller issue. Following the city election Cushing officials decided to construct only the distribution and transmission lines, without the plant, as favorable electric rates were obtained from the utility supplying the city.

▼

British Energy Output 15 Per Cent Over 1932

Not content with a record in 1932 of increasing electrical energy output by an average 7.1 per cent (ELECTRICAL WORLD, February 4, page 150), Great Britain has gone on to new accomplishments. January production of "authorized undertakings" was 1,336,000,000 kw.-hr., against 1,162,000,000 last year. This is an increase of 15 per cent.

If allowance is made for an additional half-working day this year the increase is 14 per cent. January set a new monthly record, too. The best previous figure was 1,266,000,000 kw.-hr., produced in December, 1932.

Electrical energy production has been so confidently looked to in this country as an accurate measure of the state of business well-being that it is more than reasonable to assume that it is as good a barometer of better days overseas.

▼

Court Nullifies Contract for Nebraska Municipal Plant

Contract entered into by the city of Ainsworth, Neb., with the Fairbanks, Morse & Company for the construction of a $100,000 plant in competition with the Interstate Power Company has been declared null and void by the local court. The utility company brought suit, charging fraud and collusion on the part of Fairbanks, Morse & Company with the city's engineers, Burns & McDonnell of Kansas City. While the court refused to make such a finding it maintained that there were ample grounds for suspicion and that the Council should take cognizance of what had been done in its future relations.

The evidence disclosed that the contract with the engineers stipulated that they should draw the plans and specifications for the proposed plant; to get nothing if no contract was let, but to receive $5,000 from the successful bidder. Two bids were received. On suit by the Interstate Power Company the court set aside the contract because the provisions of each of the bids with reference to smaller engine and building were exactly alike and indicated there had been no real competition.

Last fall Fairbanks, Morse & Company and the city officials of Campbell, Mo., met with similar opposition when they attempted to build and operate a municipal plant in competition with the Arkansas-Missouri Power Company, which had a franchise to serve this city (ELECTRICAL WORLD, November 19, page 674).

Water-Power Bill Opposed by Missouri Utility Men

Representatives of the Current River Power Company of Kansas City, Mo., which holds preliminary federal permits for the construction of a series of three hydro-electric dams and a power plant on the Current River (ELECTRICAL WORLD, August 13, page 194, and August 27, page 264) have declared their opposition to a bill presented by state Senator Bales of Shannon County giving the state greater control over its water-power resources. At a recent hearing before the Senate judiciary committee spokesmen for power companies denounced the protective and regulatory provisions of the bill as so unreasonable that there will be no more hydro-electric development in the state if the bill becomes a law.

Senator Bales maintains that at present Missouri has no laws to protect the public rights in water-power resources and has failed to adopt a public policy on the development of water power or the protection of the natural scenic beauty of its rivers and their valleys. The federal laws require that applicants for federal licenses must comply with the laws of the state in which they are promoting water-power projects.

▼

Municipal System Urged for Macon

If the recommendations of the special utilities committee of the Macon, Ga., City Council are adopted Mayor Toole will be called upon to appoint a group to negotiate for a municipally owned power distribution system and source of energy supply, the committee reported last week. Submission of the proposal to the voters for ratification of the project and authorization for financing through a bond issue are contemplated.

▼

Nevada Assembly Committee Favors Public Ownership

In the report filed with the state Assembly of Nevada by a committee appointed from that body to attend the power hearings just completed by the Nevada Public Service Commission it is recommended that public ownership be looked upon as the solution of that state's utility problems.

The report expresses the contention that the commission has authority to reduce rates and that it should have ordered a reduction long ago upon its own initiative. The committee recommended that no money be allowed the commission for further investigation and that if the regulatory body could not justify its existence before the close of the Legislature it should be abolished.

We found officials firmly opposed to any permanent reduction in charges; their whole energy being bent on justifying the present rates, the report says.

"We believe, from our observations," it is stated in conclusion, "that there is no hope for relief from these conditions other than by public ownership of these public utilities, to wit: Power, light, water and gas."

▼

Major New Construction This Week

Southern California Edison Company, Los Angeles, Calif., plans extensions and improvements in transmission lines at Santa Barbara, Calif., and vicinity, including power substation equipment, to cost $175,000.

Motors and controls, transformers, refrigerating machinery, hoists, conveyors, etc., will be purchased for new brewing plant of Penton Products Company, Detroit, Mich. Cost about $400,000.

Machine drives, motor, transformers, compressors, etc., will be installed in new plant near Owensboro, Ky., of Simrall Refining Company. Estimated cost over $150,000.

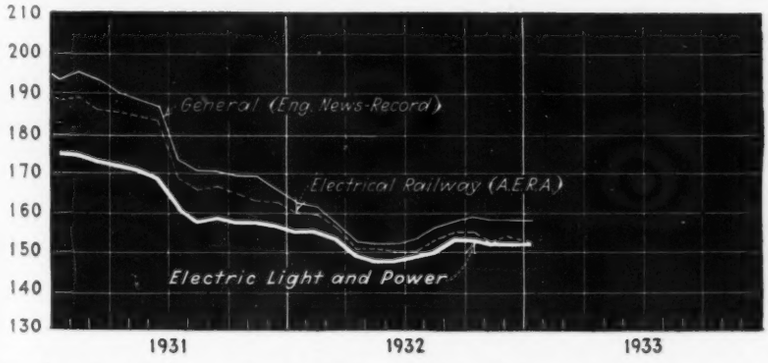
St. Charles, Mo., has called special election on March 11 to approve fund of $300,000 for city-owned electric light and power plant. Plans being completed; bids may be asked soon.

Detroit Edison Company, Detroit, Mich., is arranging fund of about $2,000,000 for construction and improvement program in 1933, including power plant, substation and transmission and distribution lines.

Motors, transformers, refrigerating machinery, etc., to be purchased by Paul Gerhardt, Chicago, Ill., for new unnamed brewing plant. Cost about $1,000,000.

Belleville, Ill., is completing surveys for city-owned electric light and power plant and plans early call for bids. Estimated cost $750,000. Also for water plant and system with electric pumps, etc. Estimated cost $1,500,000.

Slight Drop in Construction Costs



Construction Cost Indexes: Electric Light and Power, Electric Railway and General

Base: 1913 = 100

	Electric Light and Power*	Electric Railway*	General—*Engineering News-Record*
February, 1933..	150	170†	159.3
January, 1933....	152	171†	158.4
December, 1932..	152	171†	158.5
February, 1932....	155	176†	161.8
Last 5 yrs. high	185	205†	*210.4
Month.....	Jan., '30	Dec., '29	Feb., '29
Last 5 yrs. low....	148	168†	15.2
Month.....	May, '32	May, '32	June, '32

* Computed by Albert S. Richey. † Revised.

Electric light and power construction costs have lately taken a slight downward turn, the index dropping from 152 to 150, compared with 155 a year ago and with 148, the five-year minimum, last May. For comparisons not shown in the accompanying table reference should be made to the revised index numbers published in the ELECTRICAL WORLD of January 21, 1933, on page 105. Electric railway index numbers have also been revised.

Westinghouse Operations Show $8,900,000 Loss

Net loss from operations in 1932 of $8,903,540, as compared with $3,655,659 in 1931, is indicated in the preliminary report of the Westinghouse Electric & Manufacturing Company.

Sales billed totaled $77,073,586, compared with $115,393,082 in 1931. Depreciation and obsolescence of buildings and equipment to the amount of $5,274,857 were provided for and included in the cost of operation, compared with $5,173,914 in 1931.

Orders received by the company and its subsidiaries in 1932 amounted to $69,082,486, compared with $128,014,820 in 1931. Unfilled orders on January 1, 1933, were $26,836,494. Cash and marketable securities at the year end were $32,851,763, against $32,148,727 at the end of 1931.

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New York Metal Prices

	Feb. 21, 1933 Cents per Pound	Feb. 28, 1933 Cents per Pound
Copper, electrolytic....	5.00	5.00
Lead, Am. S. & R. price	3.00	3.00
Antimony.....	5.75	5.70
Nickel ingot.....	35.00	35.00
Zinc, spot.....	2.95	3.00
Tin, Straits.....	23.60	23.20
Aluminum, 99 per cent.	23.30	23.30

Philadelphia Refrigerator Sales Up

Electric refrigerator sales in the Philadelphia territory totaled 32,757 units in 1932 and amounted to some $7,085,375. This was in volume an increase of 6 per cent over 1931 and a drop of about 6 per cent in dollar values. According to the Electric Association of Philadelphia, it means that this territory reached 123.5 per cent of its sales quota, while the nation as a whole achieved but 84 per cent.

▼

North American Cuts Stock Dividend

Directors of the North American Company have declared a quarterly dividend of 2 per cent in common stock on the common and the regular quarterly dividend of 75 cents a share on the preferred stock, thus placing the common stock on an 8 per cent annual stock dividend basis, against 10 per cent previously paid.

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Another New York Reduction

Effective March 1, the electric rates in five New York state counties served by the New York Central Electric Corporation (Associated System) will be reduced by an amount which, it is estimated, will save consumers about $90,000 a year. The schedules, approved by the Public Service Commission, will not only bring a 9 to 10 per cent saving on individual bills but involve the substitution of four service classifications where eleven are now in effect.

▼

Associated Gross Earnings Decline

Consolidated statement of earnings of the Associated Gas & Electric System for the year ended December 31, 1932, preliminary to the annual report now in preparation, shows total gross operating revenues of $98,256,475, as compared with $105,286,247 for the preceding year, a decrease of 7 per cent. Domestic consumption of electricity increased during the year 1.3 per cent, but industrial power showed a sharp decline due to business conditions. Operating income after operating expenses, maintenance, all taxes, retirements, etc., amounted to $34,655,026, against $39,109,184 in 1931.

▼

River Coal at Holtwood

To date, according to the annual report of the Pennsylvania Water & Power Company, this company has had 336,000 tons of river coal dredged from the Susquehanna and it is estimated that 10,000,000 tons are on the river bottom between Holtwood and the new hydroelectric development at Safe Harbor, 8 miles upstream. The river coal referred to is burned in the company's steam station adjacent to the Holtwood hydro plant and consists of small particles of anthracite washed down by the river as it flows through the mining regions of Pennsylvania.

▼

Akron Rate Dispute Continues

Two more rounds in the fight between the Akron, Ohio, City Council and the Ohio Edison Company over lower rates have been completed. After offering a "last word" (ELECTRICAL WORLD, January 21, page 84) the Ohio Edison Company has petitioned the state Utilities Commission for authority to reduce rates. The City Council of Akron, unsatisfied with this offer, is wrangling over a far lower schedule to be submitted as its ultimatum.

▼

Montreal Would Revive Tax

With the expectation of reaping a revenue of $250,000 a year, the city of Montreal proposes to resuscitate the 5 per cent surtax on public utilities of 1918-20. The suggested charter amendment drives at the treasuries of Montreal Light, Heat & Power Consolidated and the Bell Telephone Company of Canada. Montreal Tramways Company is exempt because it already pays $500,000 annual street rental. The proposed charter amendment has already been adopted in principle by the executive committee of the Council.

▼

Oklahoma Rate Briefs

Now under consideration and examination by the Oklahoma Corporation Commission are the replies to the commission order that all electric utilities operating in the state show what rate reductions have recently been made and why further reductions at this time are not considered feasible (ELECTRICAL WORLD, February 4, page 153). An extension of time of one week was given several companies beyond the February 20 dead-line originally stipulated.

▼

So. Carolina Plans Rural Electrification

Recommending that application be made to the Reconstruction Finance Corporation for a loan of not more than $100,000 for the construction of rural electric lines, Governor Blackwood of South Carolina has transmitted to the state Legislature the report of a special committee which made a survey of rural electrification. The committee advocated construction of at least 100 miles of distribution lines along highways in various sections of the state for the purpose of practical demonstration. The Governor also recommended enactment of a bill, which already has been passed by the House, to establish a system of electrical distribution for rural uses.

Virginia League Still Active

Though rebuffed by the state Corporation Commission in its endeavor to be permitted to collaborate with that body's special inquiry into the electric rate situation (ELECTRICAL WORLD, February 4, page 148) the League of Virginia Municipalities has called another conference to decide whether or not the municipalities will engage a consultant of their own to analyze the findings of Allen J. Saville, the commission's consultant.

▼

Alabama Investigators Limited

By a vote of the rules committee of the Alabama Senate a move to enlarge the scope of the committee investigating rates charged by electric power companies, enabling the committee to employ secretaries, call in rate experts, etc., has been defeated. Opponents of the plan saw a possible $100,000 expenditure and duplication of Public Service Commission efforts. The regulatory board has expressed willingness to investigate the rate situation.

▼

Electric Power Passes Dividends

Directors of the Electric Power & Light Corporation at a meeting held last week took no action on the company's $7 and $6 preferred stocks ordinarily payable April 1. It is assumed that the dividends have been definitely passed. For the quarter ended December 31, 1932, only one-third the regular dividend was paid on the two classes of preferred stock.

▼

Another Rate Cut Asked in Dallas

Petition for a 20 per cent reduction in electric rates in Dallas has been referred to the City Council's committee on utilities for action. Agitation for lower rates is being led by W. S. Bramlett, attorney, who, in his letter to the Council, criticises "the voluntary action of the light company, which will save, under limited circumstances, the consumer 8 cents a month, which you accepted under a recommendation which I at that time correctly characterized a miserable performance. . . ." Last summer the City Council accepted a rate reduction offered to it by the utility (ELECTRICAL WORLD, August 20, page 232).

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Associated Stockholders

During 1932 the number of registered security holders in the Associated Gas & Electric System increased 17,669 to a total of 254,784, a gain of 7.33 per cent. Service customers of the system who have invested in Associated securities numbered 119,105 at the end of 1932, an increase of 14,070 during the year.

1,480-Ft., 120,000-Hp. Hydro in Spanish Pyrenees

Fed by two rivers, with two generating units operating from each and another capable of efficient operation from either, the recently completed Rio Cinca power plant of La Sociedad Anonima Hidroelectrica Iberica has some interesting features. This development in the Spanish Pyrenees is not only the largest hydro project in Spain but one of the largest in Europe.

While the power house, with its five turbines, is located on the Rio Cinca, water is drawn both from the upper reaches of that river and from the Rio Cinqueta. Units operating from the Cinca are rated at 20,500 hp., but deliver a maximum 21,700 hp. under the operating head of 1,480 ft. The Cinqueta units are designed for 30,000 hp. each under a head of 1,135 ft. The dual-purpose unit operates at 20,500 hp. on the Cinca and 14,500 on the Cinqueta, the same waterwheels being used in either case.

This development, begun in 1920 with two units, has just been completed with the placing in operation of the fourth and fifth machines.

▼

Weighing Operations Aided by Photocell Applications

Several applications of photocells to weighing operations have been exhibited recently by the Toledo Scale Company which illustrate once more the variety of photocell uses in the industrial field. The applications demonstrated employ the interception of a light beam by a vane on the weighing mechanism automatically to adjust for tare and also to control the filling of containers with liquid or dry products so an accurate net weight is obtained. The significance of this application is that it avoids any mechanical attachments to the scale mechanism which will impair its accuracy and permits automatic control of operations requiring accurate measurement.

For example, if a series of barrels or drums of the same size are to be filled with a liquid, the average tare of the series is adjusted by hand, but as each container is delivered to the scale for filling and weighing the scale indicator is automatically brought to zero by a motor-driven screw-adjusted tare balance. When this is accomplished the filling is started automatically by solenoid-operated valves. The main valve permits fast filling up to approximately the correct weight, when the photocell closes it and opens a "dribble" valve until the exact weight is obtained.

For production-line filling of packages with dry material, another scale is provided with a hopper, into which the material is sifted at a controllable speed by an electrically driven vibrating trough until the photocell stops it at the preset weight. As in the other case cited, the feed can be fast up to the approximate weight when the photocell cuts in the slow feed. (ELECTRICAL WORLD, February 20, 1932, page 349, shows as early development.)

▼

Detroit Edison Employees Aid Former Associates

Unemployment relief activities of employees of the Detroit Edison Company, supplemented by contributions by the corporation, have involved more than $85,000 since Christmas of 1931. The plan, which originated voluntarily with employees, includes temporary assistance to needy former employees in good standing.

Since the middle of 1929, 4,400 Edison employees have been laid off, principally through decrease in construction activities. The total number of employees before the reduction was 11,400. The company has added about $25,000 to the fund. Including families and dependents, the total number of persons assisted is 1,375. Many of those laid off have not needed help. Three field investigators for the company look into operation of the fund. The program does not duplicate city welfare work. If any former Edison employee applies for welfare relief from the city the company takes over the case. The aid does not include employees who left before the middle of 1929 or who were discharged for cause.

▼

Arizona Governor Balks at Wilbur's Water Offer

In response to a contract offered by Secretary Wilbur of the Department of the Interior for the delivery of water to Arizona (ELECTRICAL WORLD, February 25, page 247), Governor Moeur has notified the Secretary that his state will oppose by all legal means the proposed construction of dams for the diversion of water from the Colorado River for the Metropolitan Water District of Southern California.

The Governor declared that "Arizona could only enter into an agreement concerning the waters of the Colorado River with the approval of our Legislature, which is now in the closing weeks of its regular session. It would not appear possible to arrive at and formulate an agreement on the subject in time for its consideration by our Legislature at the present session. Moreover, the Attorney-General of Arizona advises that the execution of a contract between the United States, by the Secretary of the Interior and the state of Arizona would not satisfactorily solve the Colorado River problem from Arizona's standpoint; that Arizona's rights must be determined and safeguarded either by interstate compact or by judicial decision. Moreover, the Attorney-General advises that the proposed diversion dams for the Metropolitan Water District and the All-American Canal cannot be placed in the river without Arizona's consent.

"This is to advise you, therefore, that, by such legal and proper means as may be at her disposal, the state of Arizona will oppose the construction of said dams and the delivery of said waters until her rights in the Colorado River and the waters thereof shall be satisfactorily determined and safeguarded."

▼

Magnetic Field Research for Cambridge Laboratory

Mainly to investigate the properties of matter in highly intense magnetic fields the new Royal Society Mond Laboratory has been constructed at Cambridge, England. By means of the equipment provided there it is possible to produce fields of 320,000 gauss in a volume of two to three cubic centimeters, and while no attempt has been made as yet to secure higher fields, it is thought probable that the methods employed would permit the development of 500,000 gauss.

As a part of the studies planned at Cambridge low temperatures are desired, as with such conditions many new phenomena of interest and importance develop. The famous lead-ring experiments, in which a current once started under low temperature conditions is found to continue under the same conditions indefinitely, is an example of unusual low temperature effects.

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Gasconade Hearings Deferred

Hearings on the application of the Gasconade River Power Company of Kansas City, Mo., for a federal license to build and operate a hydro-electric power dam and plant on the Gasconade River near Arlington, Mo. (ELECTRICAL WORLD, December 24, page 840), have been deferred by the Federal Power Commission. Delay was requested by Governor Park until the Missouri General Assembly can act on a pending bill to establish state control of water-power resources. The Gasconade company now holds a preliminary permit and recently applied for a final federal license to run for 50 years. It contemplates the construction of a dam 1,800 ft. long and 130 ft. high with turbines, generators, etc., to generate 60,000 hp. The dam, power plant, etc., would cost approximately $15,000,000.

EDITORIALS

L. W. W. MORROW
Editor

Change values and make sales

UNDOUBTEDLY a part of the original capital investment of many light and power companies has disappeared because of the present value of the dollar and because of rapid technological progress. Utility managements could not foresee these changes, were under no obligation in the past to set up enormous reserves and it would not have been in the public interest to have accumulated large reserves. In fact, regulatory authorities would not have permitted this action and they even frowned very frequently upon depreciation reserves sufficient to write off the capital at the end of the useful life of the tangible property it represented, while at the same time forcing expansion in expectation of a profitable return.

These conditions reflect themselves upon the present utility business situation. A new private plant or municipal plant can be built at current values and, assuming the same depreciation rates, these new installations often will have lower fixed charges than the competing utility. In addition there may be savings in operating and maintenance charges resulting from the technological advances. In many parts of the country this competition is occurring, and it would be greater were it not for the difficulty of raising money at present. These local economies do not take into account the over-all economies of a regional power supply, which is the basis of a utility enterprise.

What should the utilities do to meet this situation? There should be a write-off of old investments against capital surplus to conform to changes in dollar values and a write-off against earned surplus to compensate for the obsolescence caused by technological progress, for this is clearly an operating charge. In addition there should be some readjustment in outstanding securities. These are drastic moves and difficult to make, but they are more and more necessary under the continued economic pressure and the increased local competition.

But these actions are largely conservative and defensive. They should be accompanied by very aggressive compensating action in sales expansion. These changes in values and the clamor for rate reductions are best met by an increase in revenues and the full sales use of inducement rates. If these conditions are used to develop more business, then the status of the industry, both as regards its financial position, competitive situation and public relations, may be improved despite the decreases in book values and rates. Losses only will be incurred by defensive measures or inertia, but there is a big business opportunity awaiting those executives who face the facts courageously and anticipate forced changes by using them to the advantage of their properties. Any capital released by write-downs and, in addition, new capital should now be spent in developing sales. This is no time to conserve capital because of changed values or fear of the future; it is a time to use capital to expand revenue-producing facilities.

Half-way selling fails

THE home is the most profitable market confronting the electrical industry at this time. It can be sold by working in each community to get each factor in distribution operating under a co-ordinated plan so that each does the work it can do best. This market cannot be sold by sitting in stores or by fooling with old sales methods. It must be contacted effectively and often and sales programs must be geared and timed to bring collective action to a sales focus.

Utilities, for example, have passed the stage wherein they did all the merchandising to a stage

where many sit inert for fear of disturbing dealer or public relations by aggressive or selfish selling. Half-way merchandising is just as bad as no merchandising or selfish merchandising. Either a utility should quit merchandising on this basis or get busy on the development of co-ordinated community merchandising. There is no compromise. In this period the utility should take the lead in each community in developing aggressive merchandising whereby all sales outlets sell the home under a co-ordinated plan. Before the utility ceases merchandising, if ever, it must help develop other sales outlets.

Manufacturers, jobbers, dealers and other sales outlets also must find the job they do best and perform their functions under a co-ordinated plan in each community. There must be a united front in each market area, there must be a definite and co-ordinated community mechanism, there must be money spent for the creation of consumer demand and the maintenance of maximum consumer contacts and there must be a community will to sell. If these policies are developed into active practices there will be profitable business for the industry.

Action by trade associations needed

LOCAL and national trade associations in the electrical industry now have a long-awaited opportunity. They are needed as never before to fix policies, determine practices and bring group action to bear upon industry problems and opportunities. Electrical manufacturers face new conditions and have many problems that can be solved by group action. Conditions are so desperate that power will be granted N.E.M.A. to take positive action on policy and practices if its officers will assert leadership. The new Edison Electric Institute can be of untold value to the utilities and it should at once put into action the splendid committee of operating property executives with power to institute and maintain invaluable sales and engineering committee activities. There is more needed than policy announcements in this critical period. Analogous conditions prevail in the jobbing and retailing fields, so that their trade associations should be aggressive and helpful.

Too many executives in each branch of the industry are immersed in their individual troubles. Too many trade associations are concentrating on saving money and collecting dues from members. This is a time when the trade association can and should justify itself by doing major work and individual executives can find the strength and power in joint action to bring desirable business developments.

What the N.E.L.A. exhibition committee has done

IN LIQUIDATING its reserve fund of about $10,000, last week the exhibition committee of the N.E.L.A. distributed 226 checks to present members of the association who have exhibited at recent conventions. This group of manufacturers has made a splendid contribution and is entitled to the thanks of the industry as it closes out its fine record of service.

For 26 years these N.E.L.A. convention exhibitions at Atlantic City have provided the manufacturers of apparatus, equipment and appliances an invaluable opportunity to present their products for the inspection of the power industry. They have also brought periodically to the power men a chance no less valuable to review the progress of the art. This has been accomplished at remarkably low cost. For the average expense to exhibitors in recent years has been 35 cents per square foot, against from two to three dollars a square foot in other comparable expositions conducted on a commercial basis. In the last five years the committee has handled more than $300,000, returning all profits to the exhibitors.

Work of this character is the essence of unselfishness. It involves a heavy burden of time freely given by companies and labor cheerfully performed by individuals, that each exhibition might be complete and add to the success of the convention. F. H. Gale and S. A. Doane have done wheelhorse work on the committee since its beginning, Carl Pierce for more than half that time. E. W. Goldschmidt has been chairman for seven years, L. W. Shugg has managed each exhibition for ten years. What these men and their associates on the committee have wrought will not be forgotten, and it is to be hoped that the work may continue under the new Edison Electrical Institute when its plans are formed.

Scheduling Units for Maximum Over-all Economy

By C. C. BALTZLY
General Superintendent of Station Operations
Philadelphia Electric Company

How the conflicting problems of operating at maximum economy and still preserving local reserve to assure reliable service are being handled

ALMOST important consideration in allocating loads and reserve capacity to generating stations is the scheduling of the number of generating units to go on the line at each generating station. The importance is not only due to the effect on system economy but also, from the standpoint of providing reserve capacity, to cover the failure of any major piece of equipment. This reserve capacity can be unnecessarily costly if the economy element is not kept in mind when scheduling generating units or machines.

A helpful factor in considering the economy of operating various machines is the no-load hourly cost of operating each machine. For steam machines the no-load hourly fuel consumption is the principal component of the no-load cost and this can be determined from the steam-input versus kilowatt-output or "Willan's line" for each unit based on test or guarantee. The projection of the Willans line to no load determines the no-load steam consumption, from which can be computed the corresponding coal or other fuel input based on the boiler performance. The fuel consumption required for the auxiliary power associated with the operation of the main unit at no load should also be included in the no-load fuel for the unit. The total no-load fuel consumption for main units of 30,000 to 50,000-kw. capacity approximates 8 per cent of the total fuel required for full-load operation.

There are three phases to be considered in scheduling main units. These will be taken up in detail separately.

1. Incremental Loading of Stations Affected by Machine Scheduling—In general, the smaller machines in a system have lower no-load fuel consumptions. However, these machines are generally installed in older stations and have higher incremental fuel rates than the larger, more modern machines. Therefore, if any appreciable load is available, it will be more economical to place the larger machine in service instead of the smaller machine, because the increase in no-load fuel consumption will be more than compensated for by the reduction in incremental rate corrected for transmission loss. If the load is of short duration, however, it may pay to put on the smaller machine, considering the lower cost of warming up and starting the machine. The latter cost is approximately the same as the no-load fuel consumption.

To illustrate this, assume that an increase in system load of 20,000 kw., having a duration of two hours, is to be generated at either station A or station B. To supply this load an additional unit must be placed in service at either station. These units have the following characteristics:

	Characteristics of Units in Station A	Station B
Capacity (kw.)	60,000	30,000
No-load consumption (lb. per hour)	3,800	2,400
Incremental coal rate for 20,000 kw. corrected for transmission loss (lb. per hour)	0.85	0.92
Coal required for starting up unit (lb.)	3,800	2,400

The additional coal consumption at each station is as follows:

	Coal Consumption for Units in Station A	Station B
Coal required for starting up (lb.)	3,800	2,400
No-load coal for two hours (lb.)	7,600	4,800
Incremental coal consumption for 40,000 kw.-hr. (lb.)	34,000	36,800
Total coal consumption (lb.)	45,400	44,000

The unit in station B requires 1,400 lb. of coal less than the unit in station A and should be placed in service even though it has a higher incremental rate.

If the load to be carried were sufficiently greater than 20,000 kw. the larger unit would be the more economical. The choice of which unit to be placed in service, therefore, depends on the amount of load available and the length of time required, and it is necessary to consider each individual case separately under similar conditions.

2. Reduction in Extra Machines Required for Reserve—In a system where a number of generating stations are connected by transmission tie lines of limited capacity reserve turbine capacity must be scheduled in the different parts of the system so that failure of any piece of equipment will not impair service. To provide the reserve additional turbines must sometimes be placed in service in excess of most economical load requirements. The additional fuel required for these extra machines corresponds to the no-load fuel consumptions on these units. It is, therefore, advantageous to keep a record of the extra machine-hours resulting from placing additional machines in service in excess of economical load requirements.

The number of extra machine hours can be reduced by scheduling loads to generating stations so that the loads will be carried as economically as possible on those units which must be placed in service for reserve. Thus, it is frequently economical to transfer the load from one

station, where a unit can be taken out of service without impairing reliability, to another station having a slightly higher incremental cost, but where it is necessary to carry extra units for reserve. The saving in no-load fuel consumption due to extra machine hours will usually overbalance the slight increase in incremental costs.

Another factor in reducing extra machine hours is the utilization of reserve available from interconnected companies. It is also sometimes practical to transfer load demands from one transmission substation to another in order to reduce reserve requirements. In any event, the load dispatcher, or whoever is responsible for the allocation of loads and scheduling of turbines, should have a knowledge of the costs involved in scheduling extra units in service in excess of load requirements, as he is in a position to effect appreciable savings by careful attention to the reduction of extra machine hours.

A specific example of the way in which extra machine hours can be reduced is afforded by the change from double-bus to single-bus operation at Delaware station. The reserve requirements under each method of operation are discussed under Fig. 1 a and b. For the particular loads indicated the rotating capacity was reduced from three 30-kw. machines to two units, or one machine in excess of economic requirements. By transferring load demands from the Delaware bus to other transmission substations, and thereby reducing the bus load from 80 megawatts to less than 64 during certain periods, it has been practical to run only one machine at Delaware during these periods. This has further reduced the number of extra machine hours run at this station.

A record of the extra machine hours in excess of most economical load requirements for the entire Philadelphia Electric Company system is shown for each year from 1929 to 1932 inclusive in Fig. 2. A steady reduction since 1929 has resulted and the corresponding decrease in fuel expense represents an appreciable item in the savings effected on this system. The saving in fuel expense due to the reduction in excess machine hours in 1932 as compared to 1929 amounted to 1.5 per cent of the total fuel expense for 1932.

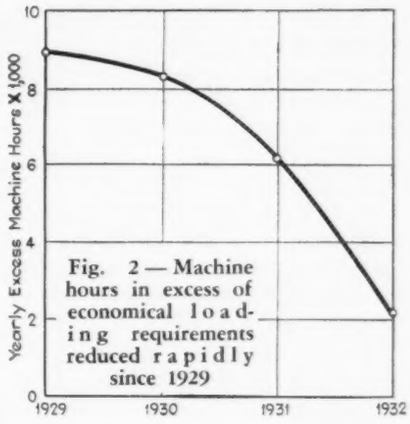

Fig. 2 — Machine hours in excess of economical loading requirements reduced rapidly since 1929

3. Less Efficient Stations Shut Down During Light Loads —When the system load is light, during early morning periods and Sundays, appreciable savings can be effected by shutting down the less efficient generating stations. If these stations were operating during these periods most economical loading would require placing a minimum of load on them. By shutting down these stations not only can an incremental saving be effected by transferring the load to a more economical generating station, but the no-load fuel consumption on the unit can be saved.

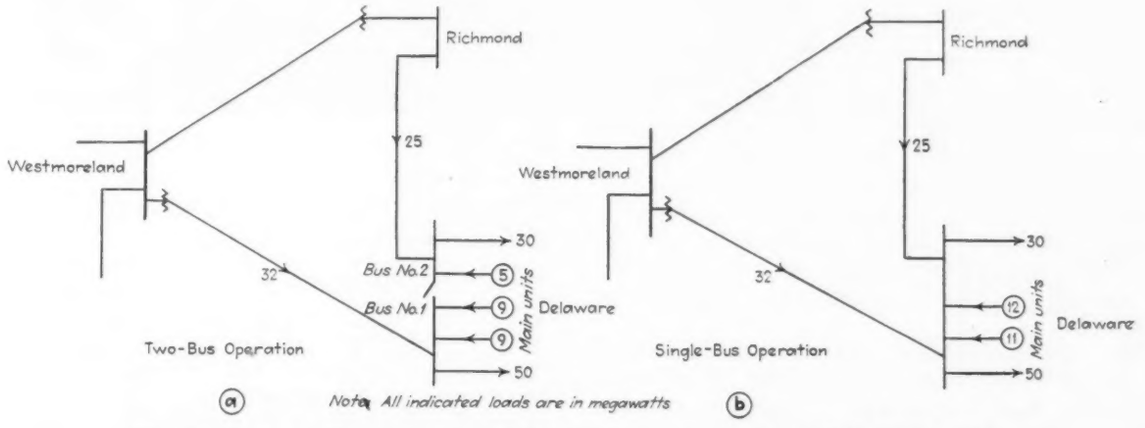

Fig. 1 a and b—How reserve requirements were reduced at Delaware station

Originally two buses were operated at Delaware station. Bus No. 1 was connected to Westmoreland substation by two transmission lines having a total capacity of approximately 32 megawatts. Three Richmond-Delaware transmission tie lines, also with a total capacity of 32 megawatts, were connected to bus No. 2. Each of the six machines at Delaware has a rated capacity of 30 megawatts. With 50 megawatts load demand on bus No. 1 the load on this bus could be carried by one machine supplemented with the power transmitted from Westmoreland. However, if the unit failed, service could not be maintained without additional generating capacity at this station, as the connected transmission lines would not have been sufficient to carry the load. Therefore, it would be necessary to run two machines on bus No. 1; these would also provide ample reserve for the failure of one of the Westmoreland transmission lines.

With a load on bus No. 2 of only 30 megawatts it would be necessary to run only one unit on bus No. 2, as the Richmond transmission ties would have enough capacity to supply the total load if the unit failed. Under the loading conditions shown the two Delaware machines on bus No. 1 would be loaded at 9 megawatts each and the machine on bus No. 2 at 5 megawatts. The total load on Delaware station would then be 23 megawatts, which could most economically be carried by one machine.

Recently it was found practical to close the tie breaker between buses Nos. 1 and 2 at Delaware and operate single bus, even though a loop was formed from Delaware to Westmoreland to Richmond and back to Delaware again. The power flow around this loop can be controlled by polyphase regulators installed on both the Delaware-Westmoreland and Delaware-Richmond transmission lines. By operating single bus at Delaware it is not necessary to carry reserve for each bus separately, and the same loads shown in (a) can be served reliably with one less machine. With a total bus load of 80 megawatts and with two units operating the failure of one unit will not impair service as the remaining capacity is 64 megawatts for the transmission lines and 30 megawatts for the other unit. This change in procedure was responsible for a large reduction in the number of extra machine hours.

When the generating stations are shut down it is necessary to rely on transmission capacity for reserve. To permit shutdown the load in the area must be less than the transmission capacity which would remain if the largest unit of transmission were to fail. For this reason it was not practical to shut down Delaware station before single-bus operation was started, as enough reserve transmission capacity was not available for each bus with two-bus operation.

It may pay to shut down generating stations for periods as short as two hours, if sufficient incremental saving can be made to overbalance the starting-up losses. This is the case when the load on the station to be shut down can be transferred to Conowingo at times of high river flow. This type of operation, however, requires skill on the part of the boiler plant personnel, together with a large measure of co-operation between the load dispatcher and the station forces, as the major part of the savings can be lost and increased maintenance can be incurred if the load is not carefully reduced prior to shutdown.

In shutting down stations for short periods the load dispatcher gives the station boiler plant personnel the estimated load reduction schedule for several hours before shutdown. The greater the load to be reduced the more time is given for getting the fires in condition. As the load on the last unit is decreased the steam pressure is allowed to drop to approximately 60 per cent of normal and the stokers are shut down. After the last unit has been shut down the pressure starts to rise slowly, and by the time the plant is ready to start up again the pressure is nearly up to normal. The rise in steam pressure during the shutdown period provides an economical outlet for any excessive heat from the fires or settings. In order further to absorb the heat from the fires after shutdown extra feedwater is injected.

On the Philadelphia Electric Company system shutting down steam stations is especially economical during light load periods when maximum hydro output is available to Conowingo. During such periods all the steam-generating stations with the exception of Deepwater are shut down and the entire system load is practically carried by Conowingo. No operating difficulties or increased maintenance have been experienced due to shutting down stations over short periods of time.

The methods outlined in this paper have been in effect for a sufficient period of time to prove that all the anticipated savings have been realized.

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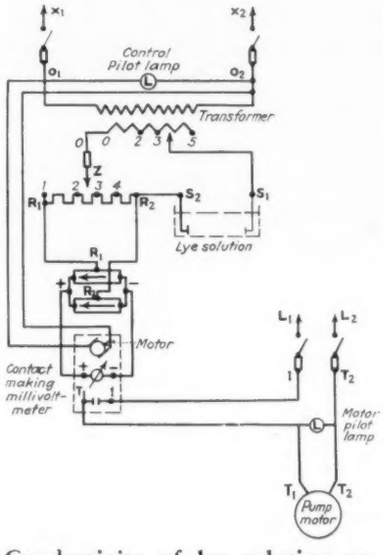
Controlling the Density of Solutions Electrically

By HARRY M. PILLARS
Engineering Department, Food Machinery Corporation

Developed to control the density of lye solutions when used for peeling such fruits as peaches and apricots, an instrument called the "Ly-O-Stat" saves time and money in canning plants, particularly when used in connection with the Dunkley peeler. Its application, however, is not limited to the control of lye solutions, but may be used to record, indicate and control directly any solution the density of which is a function of the electrical conductivity.

Lye solutions used in peeling peaches vary in density from 0 deg. to 12 deg. Baumé, depending on the fruit. It is desirable, in any particular instance, to maintain the solution within plus or minus one degree of a predetermined point.

The new apparatus consists of a Brown indicating control millivoltmeter or pyrometer, with the usual thermocouple replaced by a circuit through the two electrodes submerged in the lye solution. The latter is energized from the 110-volt line through a low-voltage transformer having several secondary taps. The secondary circuit passes through the solution to a copper oxide rectifier, which establishes the direct current required by the contact-making millivoltmeter. A shunt resistor, having four taps with link adjustment (the latter being mounted on the face of the panel for greater accessibility), is placed in the circuit in order to enable the operator more easily to adjust the instrument. The concentrated lye solution pump motor is connected directly to the line through the mercury switches of the millivoltmeter.



Conductivity of lye solution automatically controls its strength

After the lye solution has been brought to the proper density, as determined by a hydrometer, the control panel is energized and a resistance tap selected to give a deflection of the control instrument indicator of approximately one-half scale. The control points of the instrument are then set to coincide with the indicator and the lye solution pump circuit is closed. This pump will then be started and stopped by the instrument, depending on whether the indicator point is below or above the control point. During the run the density of the solution may be varied by moving the control point of the instrument in either direction.

There must be a good circulation of the lye solution in the tank where the electrodes are submerged so that the solution between the electrodes will be a true criterion of the density of the whole to guard against a false reading of the instrument. And as the conductivity of a lye solution varies with the temperature, some form of thermostatic control should be provided if the instrument is to function accurately. Indicative of its extreme accuracy and sensitivity, when the control was set to indicate a maximum of 9 deg. Baumé, the instrument holds the solution to approximately plus or minus two-tenths of a degree Baumé.

Central-Station Earnings 7.5 per Cent Under 1931

OPERATIONS of electric light and power companies continue about 7 per cent lower than a year ago. December revenue, on the basis of returns received by ELECTRICAL WORLD, is estimated at $171,880,000 (including intercompany purchases), or 7.5 per cent less than in December of 1931; operating and maintenance expenses were $72,350,000, down 8.8 per cent; energy generated amounted to 6,648,405,000 kw.-hr., a decrease of 9.7 per cent. In each item there was, as is usual at this season, an increase compared with November; revenue was greater by 1.3 per cent, output by 2.3 per cent, although the average daily production underwent a slight decline, from 216,000,000 kw.-hr. to 214,000,000 kw.-hr., making it 11 per cent under the December average for the five preceding years.

Net income, before deductions for taxes, depreciation or sinking fund, decreased about 6 per cent, from $106,280,000 a year ago to $99,530,000, the change being approximately the same as for November. Output from fuel was 700,000,000 kw.-hr. less, saving some 500,000 tons of coal.

Production from water power was almost the same as a year ago, but compared with November there was a decrease of 6 per cent in average daily production from this source, notwithstanding more than normal precipitation in most water-power regions, according to the U. S. Geological Survey. Hydro-electric energy was 39 per cent of the total output; a year ago it was 35 per cent.

Comparison of the various geographical regions reveals few important changes from November. In the predominantly industrial areas, comprising New England, the Middle Atlantic and the East North Central states, the disparity in revenue compared with 1931 widened somewhat, as it did also on the Pacific coast; for the South Atlantic region the returns show a moderate improvement, but in the South Central and Mountain states revenues remain a full 10 per cent lower than in 1931.

Output in New England decreased both relatively and absolutely, whereas in the adjacent Middle Atlantic region it approached the 1931 output much more closely than in November. In the West South Central and Mountain states, where production has lately been far short of the preceding year's, the gap is smaller than in November, though still large.

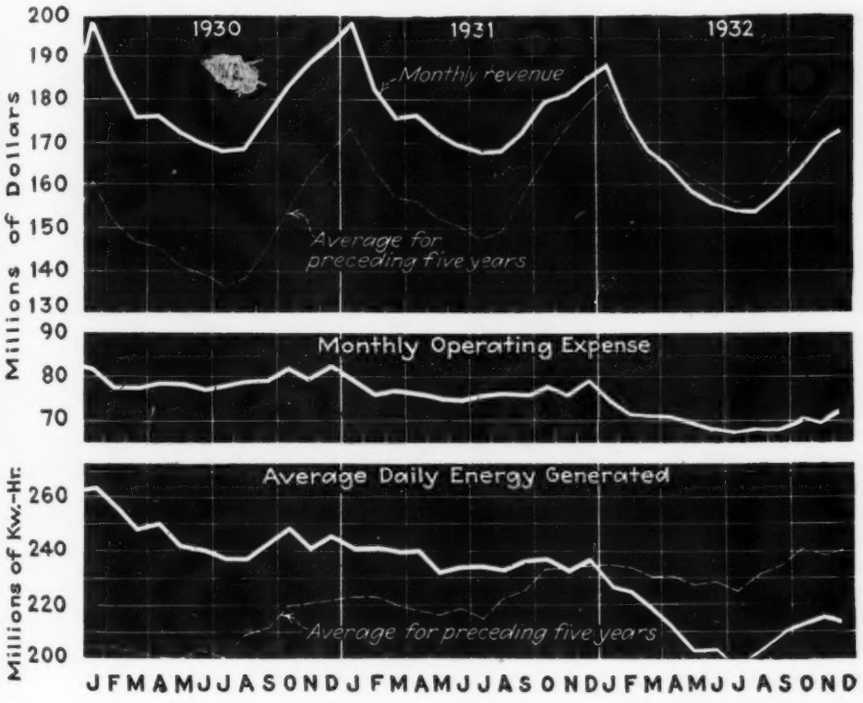


Table I—Energy Output of Central Stations in the United States

Compared with Corresponding Month of Previous Year

Month 1932	Generated, Thousands of Kw.-Hr.*						Purchased for Resale	
	Total		Hydro		Fuel			
	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Thous. Kw.-Hr.	Per Cent Inc.
September	6,297,221	—11.2	2,230,616	+ 9.9	4,066,605	—19.9	1,876,000	+ 1.0
October	6,589,989	— 9.5	2,499,484	+27.2	4,090,505	—24.1	2,044,000	+ 7.2
November	6,499,302	— 6.8	2,671,632	+37.2	3,827,670	—23.8	1,885,000	+ 3.5
December	6,648,405	— 9.7	2,577,986	+ 0.3	4,070,419	—15.0	1,982,000	+ 7.0

Table II—Regional Operation, Revenue, Energy Output, in December, 1932

Compared with Corresponding Month of Previous Year

Region	Revenue		Energy Generated, Thousands of Kw.-Hr.*					
			Total		Hydro		Fuel	
	Thousands of Dollars	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.
United States	171,880	— 7.5	6,648,405	— 9.7	2,577,986	+ 0.3	4,070,419	—15.0
New England	18,744	— 6.0	457,566	— 8.5	262,546	+15.0	195,020	—28.3
Middle Atlantic	46,569	— 7.0	1,825,602	— 4.5	547,276	+ 8.2	1,278,326	— 9.1
East North Central	40,279	— 8.1	1,564,779	—10.7	154,643	—27.3	1,410,136	— 8.3
West North Central	14,421	— 7.2	442,205	—14.7	99,975	—41.2	342,230	— 1.7
South Atlantic	18,243	— 4.9	786,182	— 4.2	477,783	+18.5	308,399	—26.0
East South Central	5,581	—10.4	220,265	—17.7	172,113	—29.2	48,152	—21.2
West South Central	9,336	—10.2	325,643	— 8.7	6,726	+74.2	318,917	— 9.3
Mountain	3,932	—11.6	189,033	—14.9	137,048	—11.2	51,985	—24.4
Pacific	14,775	— 8.2	837,130	—14.0	719,876	+11.1	117,254	—64.1

*By courtesy of U. S. Geological Survey, with deductions for operations not regarded as central-station operations.

Table III—Central-Station Financial Operations in the United States

Compared with Corresponding Month of Previous Year

Month	Total Gross Revenue from Sale of Energy*		Total Operating and Maintenance Expense†	
	1932 Thousands	Per Cent Inc.	1932 Thousands	Per Cent Inc.
Sept	$159,040	— 7.5	$68,410	— 9.1
Oct	165,410	— 7.4	70,060	— 9.1
Nov	169,730	— 6.9	69,390	— 7.8
Dec	171,880	— 7.5	72,350	— 8.8

*Aggregate gross revenue from consumers and from other utilities for energy for resale, involving a certain amount of duplication.

†Does not include interest, taxes, depreciation or sinking fund, with some unavoidable exceptions.

2,400-Volt Regulators Control 12.5-Kv. Bus Voltage

By C. E. SCHNELL
Designing Electrical Engineer
San Joaquin Light & Power Corporation, Fresno, Cal.

THOSE responsible for the finances and the operation of electrical utilities are constantly impressed with the necessity of keeping in service just as long as possible every piece of equipment in their care. Providing maintenance expenses and losses are low, there is no justification to discard apparatus just because it is old, particularly when, by the addition of standard equipment, service can be greatly improved and the old equipment made as valuable as that of recent design and manufacture.

On the system of the Midland Counties Public Service Corporation use has been made in two installations of standard 2,400-volt outdoor automatic induction voltage regulators in the neutral ends of Y-connected transformers for supplying regulated voltage to 12,500-volt station buses. The transformers to which this form of regulation has been applied have a service record of twenty or more years.

With substation transformers purchased prior to 1912 having a high-voltage winding of 40,100/69,500-volt Y with taps and a low-voltage winding of 6,683/11,500-volt Y with taps, distribution voltage requirements have created a need for a higher secondary voltage than has been possible to obtain with these transformers except by the use of the 36,000-volt tap on the high-voltage winding. Aside from the great increase in exciting current, with its resultant disadvantages due to the use of this tap, system transmission voltage variations with seasonal and daily load changes, as well as the regulation of the transformers themselves, have made it desirable in the interests of good service to provide some form of automatic voltage regulation so that the voltage of the station bus will be maintained at 12,500.

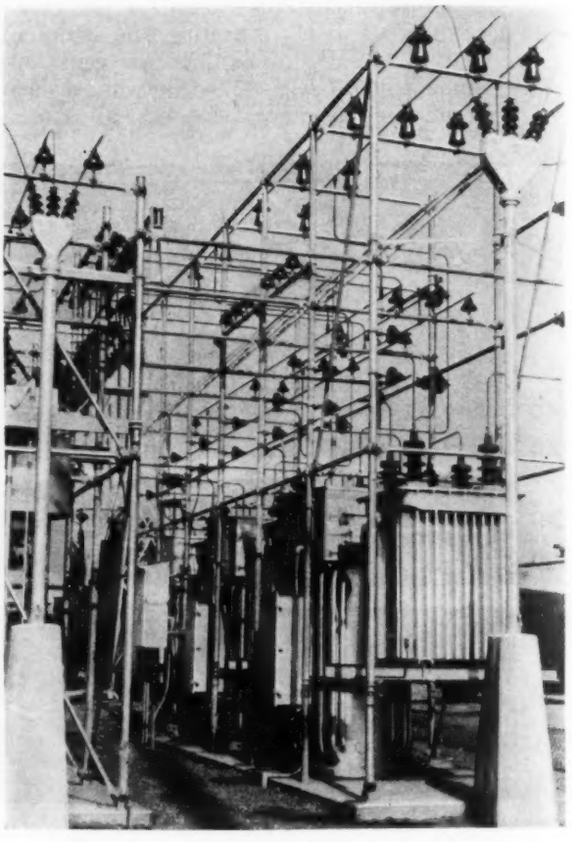
Companies in their endeavor to squeeze the maximum return out of their existing equipment investment may be inclined to adopt expedients.

But serious consideration should be given to the question of whether it would not be more economical in the long run to take advantage of the new equipment in the market at the present favorable prices of apparatus and labor, which will handle this problem of regulation with more permanency.

At least no expedients should be adopted which will make it more costly later to take advantage of tap-changing feeder and load-center transformers. Units of this type as small as 300 kva. are reported to be available for pole mounting.

The author of this article says:

"If from time to time there can be pointed out new applications of standard equipment which at a reasonable cost will continue in more satisfactory use the apparatus in which our investment has been made and whose usefulness has not been impaired, but which otherwise does not quite fit into the scheme of things, then I believe we are making a worth-while effort. To maintain the investments in our companies in the highest state of efficiency and usefulness is indeed a real job."



Regulators and exciting transformers at San Luis Obispo substation

The problem, therefore, was to use existing transformers and to add some form of voltage-regulating equipment which would not only regulate but would also add considerable voltage when necessary—the whole to be within the limits of value received for the money expended. Several methods have been tried in the past, but careful consideration led to the decision to use outdoor automatic induction voltage regulators of the 2,400-volt class, one regulator in the neutral end of each transformer winding and each excited by a 6,900/2,300-volt transformer in that phase to give proper phase relation between excitation and load.

Reference to the accompanying diagram shows the method of connections of the station transformers, regulators, exciting transformers, oil circuit breakers, etc. As will be noted, both banks are regulated by potential transformers connected to the station bus. Either bank, however, may be cut out of service without interfering with the regulation of the other bank. The two banks may also be operated without regulators should it be necessary to take the regulators out of service for inspection or maintenance.

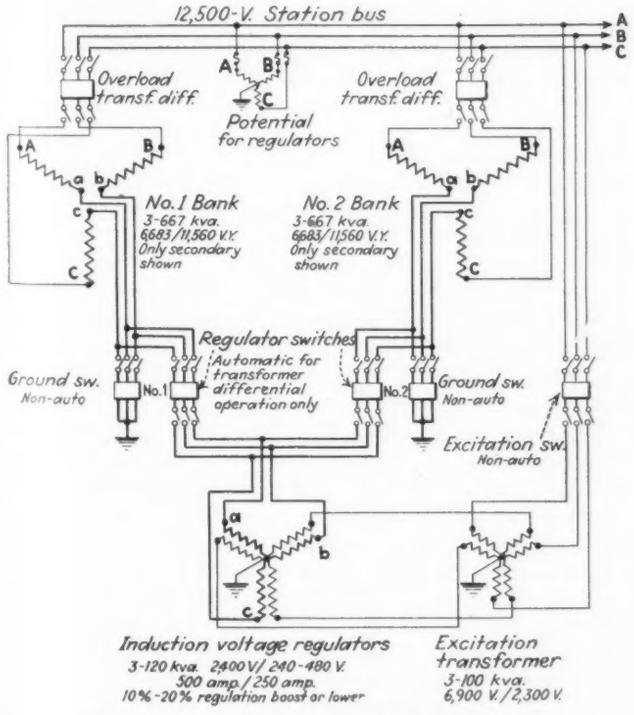
Connections of the regulators are for 20 per cent regu-

lation boost or lower, which means 480 volts is added to the 6,683-volt winding, thus making the bus regulation somewhat over 7 per cent either way. Should future load conditions demand, the regulators can be connected for 10 per cent regulation, thus handling twice the output with one-half the present regulation. This would permit the use of larger transformer banks and is a future consideration of some merit.

This scheme has been used in two installations. One is at San Luis Obispo, where the combined output of two 2,000-kva. banks of transformers is regulated by three 120-kva., 500/250-amp., 60-cycle, single-phase regulators, primary 2,400 volts, secondary 240/480 volts, 10/20 per cent regulation boost or lower. The other installation is at Atascadero, where an output of 1,500 kva. is regulated by three 48-kva., 200/100-amp., single-phase regulators of the same voltages and characteristics as above.

Operation of the San Luis Obispo equipment has been had for the past year with very satisfactory results. The following tabulation of bus voltage under various operating conditions of the transmission system indicates that the range is sufficient for wide variations of transmission voltages as well as for inherent transformer regulation:

	Station Load (Kva.)	Transmission Voltage	Station Bus Voltage	Regulators Position (per Cent Boost)
Normal operation of transmission lines with both banks	2,000	72,800	12,500	2
Transmission line to south open, one bank	1,500	66,500	12,300	20
Transmission as above but with both banks	1,500	67,200	12,400	18
Transmission line to north open, both banks	1,600	75,000	12,400	8
110-kv. line at Santa Maria open, both banks	1,700	70,800	12,500	10



How low-voltage regulators are used for 12,500-volt bus regulation

The installation at Atascadero has been in service only since June, 1932, but to date it has an excellent operating record.

Satisfactory operation of equipment must be the measure of success of whatever scheme of voltage regulation is used. The only adverse criticism to this method has been that 2,400-volt equipment is used in a 15,000-volt class circuit. The answer to this is that it is similar to the use of graded insulation on the neutral end of transformer windings and to the use of transformer tap-changing equipment which has a lower voltage rating than the transformer winding on which it is used. Then, too, as will be observed from the wiring diagram, the neutral of the regulators is always solidly grounded, which should prevent any dangerous rise of potential.

Further use of this method of regulation is contemplated with existing banks of 1,500-kva. transformers using 250-amp., 20 per cent regulators, but using the 2,300-volt tertiary windings of the station transformers instead of separate transformers for exciting the induction regulators. This will reduce materially the cost as well as simplify the installation.

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Half a Century of Power

Two decades have brought a fivefold increase in public utility prime-mover horsepower and a threefold increase in its ratio to total stationary prime-mover capacity. In half a century the latter has been multiplied fourteen times.

More detailed statistics will be found in the accompanying table, quoted from a paper presented by A. E. Silver and taken from government sources.

Including mobile prime movers the aggregate horsepower exceeds a billion. A large portion of this huge amount is, of course, represented by automobiles and so is of comparatively recent growth. Its use-factor is far lower than that of the stationary power equipment.

Total Stationary Prime Movers

(Thousands of Horsepower)

	1880	1890	1900	1910	1920	1930
Manufactures	3,411	5,850	9,778	16,803	20,063	20,100
Utilities*	.....	277	2,195	8,497	20,026	44,000
Mines and quarries	650	1,300	2,754	4,403	5,112	2,750
Agriculture†	1,000	1,500	3,750	8,100	11,150	4,000
Total	5,061	8,927	18,477	37,803	56,351	70,850
Utilities, per cent of total	.....	3.1	11.9	22.5	35.6	62.1

Total Mobile Prime Movers

(Thousands of Horsepower)

	1880	1890	1900	1910	1920	1930
Animals	15,660	21,175	22,305	25,405	24,280	18,000
Automotive	.....	.....	32	7,714	230,432	890,000
Locomotives	7,720	16,300	20,900	45,400	72,300	75,000
Ships	1,110	1,444	1,900	3,122	6,584	12,000
Total	24,490	38,919	45,137	81,641	333,596	995,000
Electrical energy used in transportation	.....	140	1,079	4,500	7,500	9,000
Grand total	24,490	39,059	46,216	86,141	341,096	1,004,000
Electric transportation in per cent of total transportation	.....	2.3	5.2	2.2	0.9	

*Includes a relatively small amount of power for irrigation projects and government enterprises.

†Steam and gas engines, individual lighting plants, windmills, etc.

Lightning Protection of Distribution Transformers

Interconnecting primary arrester grounds with secondary neutral equalizes potentials, reduces hazards and improves operating conditions from a cost and service standpoint

By J. M. FLANIGEN
Assistant Superintendent Retail Operations
Georgia Power Company

THE problem of protecting distribution lines and equipment from lightning, while as old as the industry, has only recently received the study and thought necessary to reach a solution. The principal reason for this seeming neglect was lack of proper equipment and an adequate technique to develop the essential quantitative values from which reliable analyses could be made. Until the perfection of the cathode-ray oscillograph there was nothing definite upon which to base any studies. All work that was done was, in effect, groping in the dark. However, full credit should be given those who, without modern methods and apparatus, ventured into this field of the unknown.

With modern equipment, we no longer have to guess at the effects of lightning disturbances. We are able to direct it into the paths that will do the least damage, and can almost say now that we can build lines and apparatus that will be lightning-proof. From the data that have been obtained we can design to meet the average condition, but will still be subject to the few disturbances of infinite proportions. No one can yet say that we have lightning under control or that any condition is absolutely safe from lightning. We never know when a surge of unusual magnitude is coming. We not only must deal with direct lightning strokes but also surges that are caused by the line being in the electrostatic field of a cloud. The wave shape and magnitude of this surge will be dependent upon the rate of discharge and magnitude of the charge on the cloud and the distance of the cloud from the line, and may have the same effect as a direct lightning stroke.

Certain precautions and protective measures that were worked out while groping in the dark became accepted as necessities, or at least as guides to safe practices. They were based in the main upon the theory of holding the potentials of objects at or near ground potential; that all lightning is headed to ground, and that if it is made difficult for lightning to reach the apparatus, as complete protection as possible would be provided. It was commonly known that lightning did not like to reverse its direction, hence the choke coil. It was thought preferable to maintain a separate means of holding the ground potential on the component parts of the apparatus, and that if the damage spread to the different parts it was because the paths to ground were too close together.

One by one difficulties have been overcome. First and most important was the elimination of "power follow," through the development of the valve-type arrester. This answered a great number of problems and indicated that the resultant damage was not caused entirely by lightning. Next the choke coil was found to be a hindrance instead of a help, under some conditions. Its action as an auto-transformer at double frequency sometimes caused as much damage as the lightning.

Another step in the dark requiring justification was the practice of some companies in grounding the transformer case without definite knowledge of all of the factors involved. This practice was short lived, as the resulting failures in transformers indicated that the theory was incomplete.

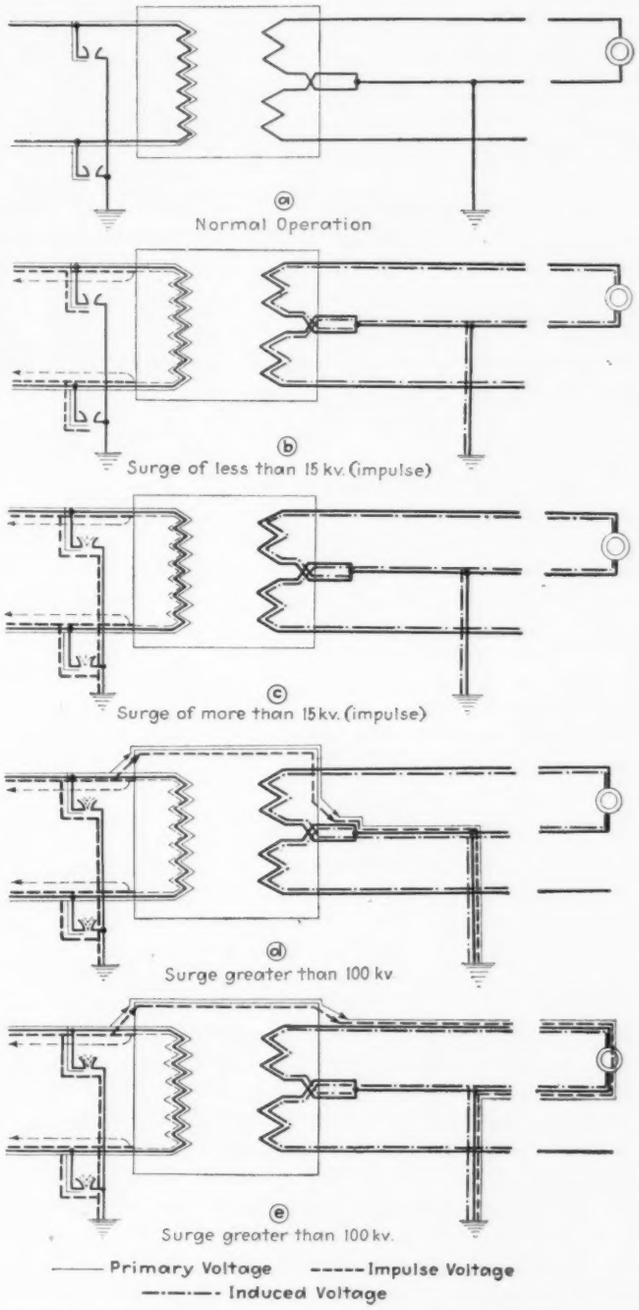
Thus we have gradually eliminated the results of groping in the dark for an answer to the lightning problem. One cause of apparatus failure remains that seems to be the result of trying to hold the component parts of the apparatus at ground potential by separate means. If we consider the distribution transformer we have the anomalous condition of a line exposed to lightning and supposedly held at ground potential by a lightning arrester and one ground of questionable resistance, whereas the transformer secondary winding is held at ground potential by a multiplicity of grounds of low resistance. Naturally the surge, having a high impedance path over the single lightning arrester ground,

builds up a potential sufficient to break down the dielectric separating the transformer windings, allowing power to flow from the primary circuit into the secondary system, with results that would easily shake one's faith in our accomplishments along the lines of lightning protection.

Now that we have a device that will stop "power follow" in all ordinary cases, why not reduce the stress in the various parts of a circuit by equalizing the potentials instead of attempting, by questionable methods, to hold them at or near ground potential? This has been done for a number of years in substation operation by connecting lightning arresters and equipment grounds together. The results have been very satisfactory. The practice is based on the theory that if the disturbance cannot be drained quickly the voltage of various components of the circuit will be raised to approximately the same potential as the surge and that to relieve the stresses imposed a multiplicity of paths must be afforded to drain the disturbance. Destruction of arresters results from restricting the path of the surge to a single ground connection with high impedance.

What occurs in distribution transformers during a lightning storm is shown by Figs. 1 a to e.

Figs. 1 a to e—What occurs in transformer circuits during lightning storms with conventional connections



A surge coming in on the primary line raises the primary potential to that of the surge, and this is limited only by the flashover value of the line, which is around 300 or 400 kv. Coming to the transformer, it produces a stress between the primary winding and the case. If the arrester operates and if it has a low ground resistance it will drain the surge voltage off and permit a return to normal condition. If the arrester and its ground connection fail to function properly the resulting stress on the primary insulation may cause a breakdown, then the case is brought up to the potential of the line and the stress on the primary winding relieved.

However, in relieving the stress on the primary, a similar stress is imposed on the secondary winding, and since the secondary insulation is a little less than one-half the primary, it is almost certain that the secondary insulation will fail. Then the surge goes on into the secondary system to drain, but in doing this it is followed by full primary dynamic voltage. Therefore, instead of a surge of practically harmless effect, lasting a few microseconds, we have a flow of dynamic power that will certainly last a few cycles, and if the line impedance is so high that the primary fuses do not blow promptly it may not clear until a great deal of damage has been done.

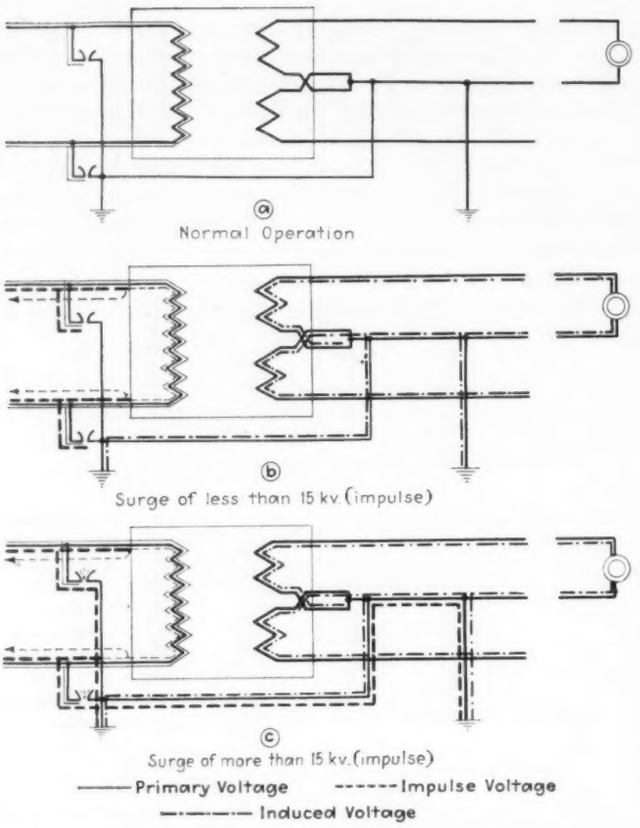
B—A surge has been impressed on the primary line of insufficient potential to operate the arrester (normally a surge less than 15 kv.). It will be noted that although the surge itself is confined to the primary circuit and is reflected back on the line, there is an induced surge on the secondary system. This latter surge is due to the electrostatic coupling between the windings of the transformer as well as to the ratio of turns. In all cases it must be dissipated through the secondary system and customer's equipment, or to ground over the neutral. This may or may not be noticeable as its intrinsic energy is very small, but it may appear as a spark jumping to ground in the customer's wiring. Its effect may never be noticed unless one were looking at the point of breakdown at the instant of breakdown.

C—The arrester is operating properly and draining the entire surge from the primary system to ground. Here again we have the secondary surge induced and it must be dissipated over the secondary system as above.

D—The arrester operates as before, but the characteristics of the arrester and its ground connection may sustain a residual potential sufficient to spill over the bushing to the case and over the low-voltage bushing to the secondary. (This failure may occur over the bushing or puncture the winding. The effect is the same on the secondary, so that it will be considered as a spill-over rather than a puncture.)

On the secondary side the surge may spill over the low-voltage bushing to the neutral. If it does the surge will probably go to ground over the neutral without any harm being done. However, when the surge flashes over the bushing the primary current follows and goes to the case, and from that along with the surge to the neutral, thence to ground. This results in the primary fuse blowing in approximately 75 per cent of the cases.

E—If, however, the surge going from the tank happens to jump to a "hot" secondary wire instead of the neutral, the surge and "power follow" go into the customer's premises, and thence to the neutral, through whatever apparatus is connected, and back to ground. This may cause damage to the customer's equipment, or not, according to the impedance of the path to ground. However, we have primary current following the surge and it may do some real damage to the equipment before the primary fuse blows and stops this flow of current.



Figs. 2 a to c—Surge conditions in transformer with arrester ground connected to secondary neutral

If we can devise some scheme that, instead of attempting to hold the line potential down to earth, provides a means of by-passing the three elements considered we will avoid stresses between parts and resulting failures. If in addition to this we can cut off "power follow" by means of a satisfactory device, such as a valve-type arrester, we will have provided a maximum degree of protection and will not have increased the hazard.

This may be accomplished by forming a path that will function during a surge disturbance between the ground side of the arrester and the tank and secondary. The modern arrester will stop power flow, and since the secondary and case always remain at approximately the same potential, we can make the connection to the secondary and accomplish the desired results.

All of the conditions illustrated in Figs. 1 a to e have been based upon a comparatively low ground resistance at the arrester. A surge of 100 kv. traveling over a line will have a current value of some 200 amp. This is a comparatively small amount of current and it is not unusual to have a surge of the order of 750 to 1,000 amp. Now suppose that a surge of this nature comes in on the line and the lightning arrester ground resistance is 100 ohms. The 1,000-amp. current times the 100-ohm resistance, giving an *IR* drop of 100,000 volts, means that the arrester cannot reduce the voltage below this amount. Thus 100 kv. is imposed upon the transformer for an appreciable time, and this will in all probability break down the insulation or flash over the bushing and repeat the conditions illustrated in Figs. 1 d and e.

Therefore, with conventional connections and the usually high arrester ground resistance and low neutral ground resistance, we are actually tempting and making it easy for the surge to break down the transformer insulation and flow into the secondary system, together with "power follow."

One answer to the problem would be to obtain very low values of ground resistance for lightning arresters. However, this will not take care of all conditions as there will be surges of such a nature as to break down the insulation before the arrester and its ground can dissipate the disturbance. Another method of handling the disturbance is to eliminate the stresses between the primary winding and case. If the potential between the primary line and the case can be equalized there will be no stress and, therefore, no failure of the primary insulation. Obviously, it is impossible to do this by connecting the case to the primary. However, the same effect can be accomplished by shunting the arrester across the primary and case.

When this is done a surge sufficient to operate the arrester gap (15 kv.) immediately brings the potential of the ground wire and the case up to approximately the same value as that of the surge. This relieves the stress between the primary and case and, therefore, prevents failure. When the surge is dissipated there can be no "power follow" through a modern valve-type arrester. Therefore, the primary current cannot get to the case. This connection would protect the primary winding, but a breakdown between the case and secondary might occur, and this may or may not go to the neutral, as outlined under Figs. 1 d and e.

Experiments have proved that the potential of the case follows that of the secondary to within 80 per cent of the value impressed on the secondary. Therefore, if the potential of the secondary is raised, the case would automatically come up to within 80 per cent of the value. And if the lightning arrester ground were connected to the neutral the potentials will not only equalize, but the surge will be directed to the grounded neutral, where it can do the least damage. This also eliminates the questionable factor of grounding the transformer case.

Therefore, if the lightning arrester ground is connected to the secondary neutral (Figs. 2 a, b, c) transformer burn-outs due to lightning should be practically eliminated, likewise fuse blowings due to lightning, because the undesirable "power follow" is eliminated. This connection has been recognized as a desirable one to make where and when the secondary ground resistance is low. The highest authorities on codes and code making are convinced of this. However, some are skeptical when the secondary ground resistance is comparatively high, but there should be no doubt that this connection is just as safe as the present method of installing arresters.

Principles applied in practice

Now as to actual operation, the Georgia Power Company made an installation of 26 Westinghouse surge-proof transformers in the town of Lithonia, Ga. While the surge-proof transformers may not be considered a direct interconnection and, therefore, not strictly comparable with the interconnection discussed, it in effect depends upon the secondary neutral in the final stage to take care of the disturbance. Its construction and operation are shown in Figs. 3 a, b, c.

The town is situated some 12 miles south and east of Stone Mountain on the edge of the granite formation. Rock is at the surface, so a good ground is very hard

to secure. The ground at the substation (52 ohms) was obtained by driving a number of grounds and treating them with copper sulphate.

Measurements of lightning arrester grounds at distribution transformers gave values of 300 ohms and up. The secondary neutral was formed into a grid which, because of the water pipe grounds on it, had ground resistances of 3 to 5 ohms. With high arrester grounds and low neutral grounds we were actually tempting fate to break down the insulation.

Lithonia is supplied from a 38-kv. line from Norcross to Porterdale, normally opened on the Porterdale side of Lithonia, so we have an exposure of some 12 miles and a great part of it is over the granite deposit. The transformers supplying this line are Y connected; the neutral is grounded at the station. The line is three-wire, three-phase and is of triangular configuration, without an overhead ground wire. At Lithonia are three 250-kva., 38,000/2,300-volt delta-delta transformers. The station is protected by line-type autovalve arresters on the high side and two sets of 2,300-volt distribution arresters on the bus on the low side. One feeder leaves the station through an automatic breaker. The station is approximately one-quarter mile from the center of town.

Comparative results

Records of past performance, while not complete in all details, showed that there was room for improvement. With a total of some 50 transformers in operation we had the following failures:

Transformer failures, 1929, two 5-kva.; 1930, 0; 1931, one 1½-kva., one 5-kva. Lightning arrester failures, 1929, 23; 1930, 23; 1931, 19.

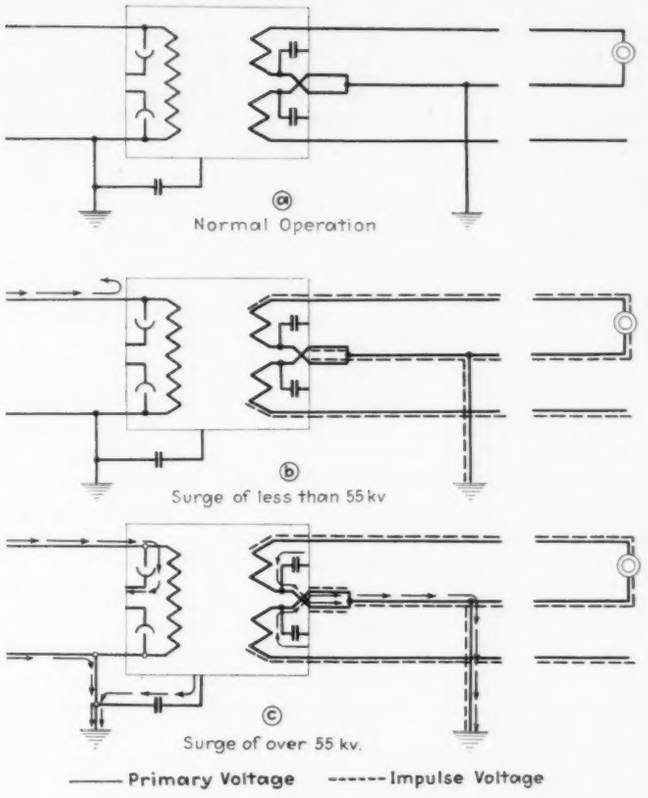
No record of the fuses blown or leads burned off were kept. In the past these have been taken as a matter of course, and at every lightning storm two service men were kept busy replacing fuses and putting on new leads.

The surge-proof transformers were installed in April, 1932, and, therefore, were in service during the greater part of the lightning season. The smallest fuse used was rated at 20 amp. and the gap lead was connected to the old arrester ground. Since that time we have not had a fuse blow; there have been no failures, nor any trace of trouble on the customers' premises traceable to these transformers.

One of the transformers was removed in August and brought into the Westinghouse service shop for examination. A careful inspection of this transformer was made to determine whether there was any evidence of arcing, particularly over the co-ordinated low-voltage bushing. No evidence of any arcing whatever, either internal or external, could be discovered by the most thorough visual examination, so a high potential test of 10,000 volts was applied for one minute between the high-tension and the low-tension windings and tank, tied together. Then a high-potential test of 4,000 volts for one minute was applied between the low-voltage winding and the tank. Both of these tests were made without any oil in the transformer, and the transformer stood both tests successfully. The oil was found to be perfectly clear and have all of the characteristics of new oil, withstanding a potential test of 25,000 volts, using the standard oil testing outfit.

A klydonograph was connected to the secondary terminals of one of the transformers, and also to the tank gap lead, from August 15 to October 1. Several lightning storms occurred during this period, but there were no indications on the film of any high voltage. During the same period, but extending back to April 1, 1932, we had twelve lightning storms with the following troubles on the 34 transformers that were not changed:

One 5-kva. burned up.
Eleven fuses blown.
Seventeen arresters destroyed.



Figs. 3 a to c—Conditions with surge-proof transformer

While the construction of the surge-proof transformer is very similar to other transformers, greater clearances have been provided and the "Delon" gaps placed on the primary leads. A gap is provided on the outside of the case and the lead from this gap may be grounded the same as the conventional lightning arrester in the past, or it may also be connected to the secondary neutral. On the Georgia system it is interconnected through a gap. However, if the lead is grounded and not interconnected, there is a gap inside the case from the case to the neutral. This gap is the final protective device that operates only in cases of the most severe surges and is the last line of defense. Its action is simply to direct the surge when not drained by the gap and ground into the neutral.
In case c the surge will go through Delon gap to case, thence through gap to ground lead and co-ordinated secondary bushing to neutral. Power flow will be limited to 300 amp. by resistor and cannot follow as Delon feature will quench the arc at first zero point on wave. Auxiliary gap lead may be tied to secondary neutral and entire surge drained into secondary with same effect as interconnection, except that surge voltage must be around 55 kv. instead of 15 kv. to cause operation.

Value of extending practice

Assuming that we could get approximately the same comparative results over our entire system, we can see possibilities of enormous improvements in service to our customers. During the year 1931 we lost some 178 transformers from lightning, a total of 1,179 kva. This was 73 per cent of the failures from all causes. All but fifteen of these were 10 kva. and less. Assuming that we had an average of eight customers per trans-

tormer and that changing each one required two hours (a very low figure, to be sure), 2,848 customer-hours of interruption might be avoided. During the same time we had 3,520 fuses blown, and most of them were during lightning storms. So assuming eight customers per transformer and one-half hour as the average time for replacing fuses we have 14,160 customer-hours of interruption.

For an idea of cost, figure 1,179 kva. at $10 per kva., labor of changing at $5 per unit, and cost of fuse replacement at $1 apiece, giving a total of $16,200, or approximately 11 cents per customer per year.

As for additional hazards, we do not believe we have them. Although we have records, covering about one-half the system, of 28 cases of primaries falling on secondary during the year; although we know that in every case of transformer failure from lightning we had "power follow" in the secondary; although we also believe that in every case of fuse blowing we had "primary follow" into the secondary (some 3,700 cases of primary getting into the secondary), still no serious damage resulted. Now with ground interconnection, or the surge-proof transformer, we may impose surge potential on the secondary, but we will in all probability stop all but a few of the 3,700 cases of dynamic voltage getting into the secondary. With the arrester placed on the transformer side of the fuse we should eliminate all of the objections to lightning protective schemes.

Conclusions

The results of this installation have been so satisfactory and a close study has proved so conclusively that there is no additional hazard that we are now installing all arresters on the transformer side of the fuse and making the interconnection wherever we have three grounds on the secondary. In those towns with four-wire distribution we are using a common neutral, and we feel that the saving in customer interruptions and transformer troubles more than outweigh the savings in copper. In other words, if there were no saving in initial construction expense we believe that resulting economies in operation will more than justify the common neutral.

▼

76 per Cent of German Homes Have Electricity

Household electrification has proceeded somewhat farther and has in recent years been making more rapid strides in Germany than in the United States. A recent report to the Department of Commerce cites the following figures:

Year	Total Households	Electrified Households	Per Cent Electrified
1925.....	11,220,000	6,330,000	56
1928.....	12,370,000	8,550,000	69
1929.....	12,440,000	9,060,000	73
1930.....	12,520,000	9,600,000	76.5

The per cent in 1925 is identical with that for the United States in the same year, but by 1930 we had risen only to 70 per cent. German companies have made vigorous efforts to increase their loads. Conditions in that country are somewhat more favorable for rural electrification than in the United States, because the agricultural population is generally concentrated in villages, the isolated farmhouse is far less common than with us and there is no parallel to our prairie states with their widely separated individual homes.

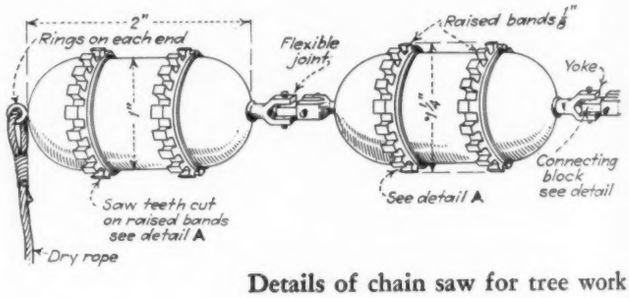
▼

Safety Saw for Tree Limbs

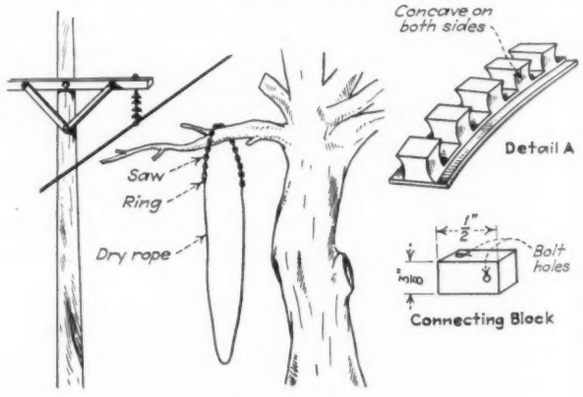
By GUY F. HARDEN

To minimize danger to linemen when cutting off tree limbs in close proximity to live high-tension pole lines, a chain type of saw manipulated by dry ropes from the ground has been used successfully. By this means branches difficult of access by climbing or ladder may be reached and falling limbs kept off the phase wires. The author was located in prairie country far from sources of supply and made up the device as follows:

The chain saw is composed of a series of steel nuggets connected by flexible joints, the nuggets being of 1½x2-in. round stock, turned or ground to leave two raised bands



Details of chain saw for tree work



or ridges on each to serve as cutting edges. The bands are $\frac{1}{16}$ in. high. The ends are rounded off, bored and threaded to receive bolts which terminate in the yokes of flexible joints as shown in the diagram. The joints are made of 1x½-in. pieces of hexagonal steel connected by ½x⅜-in. blocks provided with pinholes serving as bearings for movement in two directions. Close joints are necessary to avoid blocking the movement of the parts by twigs. Teeth are cut on the bands as shown. The device will not cut as fast as a hand saw, but will "chew" off a limb safely, and in one case where a willow tree fell upon a 33-kv. live line clearance was safely effected from the ground. The saw is kept in a box to safeguard linemen and is oiled and sharpened after each day's work.

Domestic Usage Fixes Distribution Costs

By SAMUEL FERGUSON
President Hartford Electric Light Company

NO TWO persons will give the same definition of the items which when totaled comprise "Distribution Costs," as some will list items under the caption which others will claim are not distribution, and vice versa.

I shall limit my definition to fixed and operating and maintenance costs on lines, transformers, services and meters, together with all direct expenses caused by the service of the individual customers, such as billing, collecting, trouble and lamp service, inspection, information and complaint service. Also I shall include direct taxes and such public liability insurance costs as are attributable wholly to distribution lines, but I leave out all legal and administration expenses and a multitude of general expenses to be covered under some other classification or by allocation.

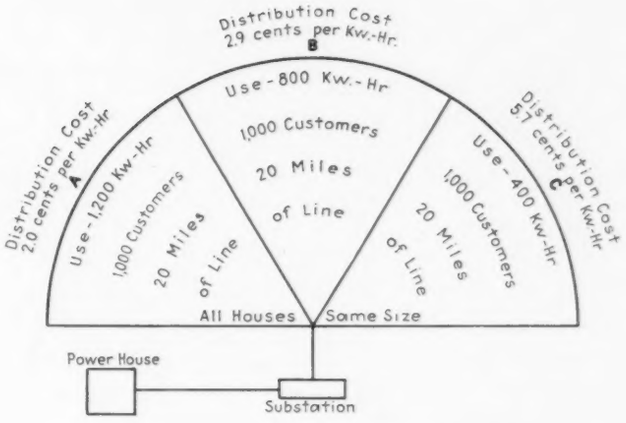
"The cost per kilowatt-hour of distribution" cannot be set up as a single universal figure for the simplest of all reasons, which is that "there ain't no such animal"—you could as reasonably ask "what is the cost per gallon of sewage disposal" without making your question any more specific.

We do have a pretty good general idea of generation and transmission costs, and therefore, why not distribution cost as well? The reason that the one is capable of being expressed fairly accurately in general terms while the other is not lies, probably, in the fact that "generation" and "transmission" costs deal with the combined requirements of all customers and the only material variables are those of plant and fuel costs and plant efficiency. With distribution, however, the situation is exactly reversed, and by far the greatest variables are those of customer density and average customer usage, while the cost per mile is relatively constant except as between overhead and underground construction.

It is always possible to obtain a figure which represents, in any territory or subdivision thereof, the quotient of cost divided by kilowatt-hours, but such quotient is only distribution cost in the limited sense of the particular cost of distribution in the case of:

1. A specific number of customers per mile.
2. A specific average usage per customer.
3. A specific ratio of overhead to underground construction.

Subject to this limited definition, I have listed in Table I the cost per kilowatt-hour of distribution taken from the books and data of six companies together with the particular conditions pertaining to each. The companies, A to F, differ greatly both as to number of customers, miles of system and customer usage. Customer density ranges from six to 93 customers per mile and usage from 436 to 1,543 kw.-hr. per customer per annum, and under these varying conditions the distribution cost per kilowatt-hour varies from 2.7 to 9 cents per kilowatt-hour. High use in the low-density town B[1] almost balances the low usage but higher density of company A.



Annual consumption determines distribution cost

If prices are to be based upon costs, these figures of distribution cost must be used in determining price to be used in the respective areas. Since it will make no difference in total distribution cost if these customers are mixed in each section instead of segregated, it follows that:

These different known distribution costs should be used in creating price schedules applicable to the different usages in the area, otherwise the price to the larger user would be burdened with the cost created by the smaller user and vice versa.

It is true that a mathematical average of these resultant figures might be made, but even then it would represent only the cost of some one particular customer density between 6 and 93, when combined with some particular customer usage between 436 and 1,543. Such a figure would be of no significance whatever as representing even an approximation of distribution cost under different circumstances, as this particular set of circumstances would not be met again once in a thousand times.

In order to follow the comparison further I have prepared Table II, wherein all underlying figures, except those of company A, are only estimates or assumptions based on experience. In this table I have corrected the cost figures of company A by estimated amounts to cor-

Table I—Variations in Distribution Cost in Various Companies and Territories

	Customers Per Mile	Kw.-Hr. Per Customer	Distribution Cost Per Kw.-Hr., Cents
Company A	93	682	2.7
Company B	16	812	5.0
Company C	58	507	4.6
Company D	8	678	9.2
Company E	6	780	8.5
Company F	10	596	8.7
Town A[1]	18	1,338	3.0
Town A[2]	39	436	5.8
Town B[1]	14	1,543	3.1
Town B[2]	40	481	5.2

These figures are taken from the books and data of companies A to F and from the data of companies A and B in the case of towns A[1] to B[2].

respond with various assumptions as to usage and density. My estimates cannot possibly be accurate, but, on the other hand, the errors in the assumptions cannot be so great as materially to affect the tremendous variations caused by the differing densities and usage. Compare under the same density assumption a usage of 400 kw.-hr. with the Canadian figure of 1,800. In the case of the 93-per-mile density the distribution cost drops correspondingly from 4.6 to 1.1 cents per kilowatt-hour.

In determining what should be the proper price of electricity what is needed is not some mythical figure for "distribution cost" which will have the weight of law, but rather that there should be some simple method of approximating what that cost will be under any specific condition. I have therefore prepared, for what it may be worth, a simple empirical formula for suburban and rural distribution costs with the aid of which any one can readily calculate the cost per kilowatt-hour of such distribution items as my definition includes. I do not claim the results to be accurate to the decimal, nor even always to the nearest whole number, but I do claim that the answer will be very much nearer to the truth in any particular case than would be an average figure obtained from the data of every community in the country even if such figures were known and were absolutely correct to the last cent.

$$\text{Distribution cost in cents per kw.-hr.} = \frac{552{,}000a + 15{,}900b + 6c}{12bc}$$

in which

a = Number of miles of distribution circuits.
b = Number of customers.
c = Average use per customer.

Calculations of Constants:

d = Customer density = b divided by a (but not less than ten per mile.
e = Investment in poles and primary = $1{,}900a$.
= Investment in transformers, services, meters, secondaries, arresters, attachments, etc., =

$$b \times \left(25 + \frac{700}{d} + \frac{c}{300}\right)$$

g = Fixed and operating costs = ... $0.15e + 0.25f$
h = Customer costs = ... $7b$
i = Total kw.-hr. = ... $b \times c$
j = Annual total cost = ... $g + h$
k = Annual distribution cost per kw.-hr. for the particular conditions covered by data = ... $100j \div i$.

Illustration:

Assume — 100 miles of lines; 2,500 customers; 1,000 kw.-hr. average use.
Then the various values become

a	b	c	d	*e	*f	*g	*h	*i	*j	*k
100	2,500	1,000	25	190	141	63.7	17.5	2,500	81.2	3.2

Then distribution costs under these conditions = 3.2 cents per kw.-hr.

* *000 omitted.*

This formula was used in the final preparation of the figures in Table II, after it was seen to be in reasonable conformity with the dollar estimates made to conform to the various assumed conditions.

Like all empirical formulas, it has been worked out backward from the known results in a few companies. If the data of a larger number of companies had been used I might have been willing to claim a higher degree of accuracy, but even as it is it will be useful in that it requires only three items of information.

One more illustration to drive home my point that it is the customer and not the company who is responsible for the resulting cost of distribution. (See accompanying illustration.)

Table II—Variations in Distribution Cost According to Changes in Density and Usage

	Customers Per Mile	Kw.-Hr. Per Customer	Distribution Cost Per Kw.-Hr., Cents
Company A	93	682	2.7
Company A[1]	93	1,800	1.1
Company A[2]	93	400	4.6
Company A[3]	30	682	4.3
Company A[4]	30	1,800	1.6
Company A[5]	30	400	7.2
Company A[6]	150	1,800	0.9

The figures for Company A are taken from the books and data of that company. The figures for Company A[1], A[2], etc., are those of Company A plus or minus estimated changes in investment and operating costs to conform to assumed conditions of density and usage.

There are three sections, all identical, except that in C all houses use only a minimum of light, while in B they use somewhat more light, a flatiron and vacuum cleaner, and in A a refrigerator has been added. Note the results:

In territory A the distribution cost is 2.0 cents per kw.-hr.
In territory B the distribution cost is 2.9 cents per kw.-hr.
In territory C the distribution cost is 5.7 cents per kw.-hr.

and the only difference is usage.

Prices, if based on cost, must in these respective territories reflect these differences in distribution cost per kilowatt-hour even though they are large.

Now the total distribution costs will be neither more nor less if these houses should be mixed up throughout all sections, and it follows therefore that any price schedule which follows such clearly defined cost differences must recognize the tremendous lowering which comes in the cost of distributing current to any given customer as his usage increases.

In order to give as clear a picture as possible, I have eliminated many minor variables which will occur to you. I have not tried to give an answer to an impossible question, nor have I "ducked" the question, but I have indicated a simple method by which you can determine approximate distribution costs when the question arises, and this I think is of far more value than a meaningless answer equivalent to an answer as to the "cost per gallon" of sewage disposal if obtained from an average of the costs of all existing sewage systems without reference to variations in houses per mile or gallons per house.

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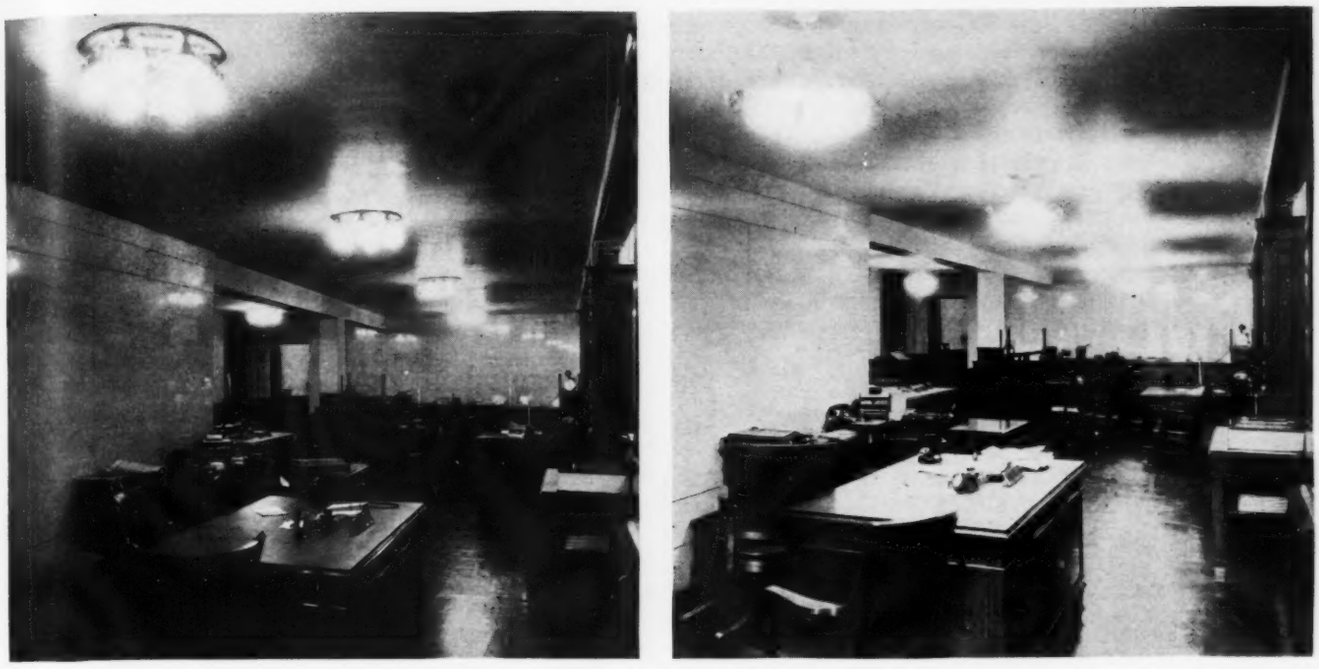
Savings in Industrial Installations*

"Considerable savings have been made as a result of studying heat-treating costs. One manufacturer installed flexible, accurate, modern electric furnaces and he says he 'has simplified operations, increased production from 20 to 50 per cent and eliminated rejections.'

"Another manufacturer by the installation of electric heat-treating equipment saved considerable floor space and reduced costs more than 50 per cent. Still another, sending his work out for heat treating, found the installation of an electric furnace paid for itself in a year."

* *From the power sales files of the Cleveland Electric Illuminating Company, cited by W. E. Benninghoff to Electrical Maintenance Engineers Association at Electrical League of Cleveland.*



Before and after relighting

Relighting a Banking Room

By ROY A. PALMER
Illuminating Engineer Southern Public Utilities Company

WHEN the building for the American Trust Company, Charlotte, N. C., was remodeled the lighting equipment for the main floor banking room was evidently chosen on the basis of what was considered good appearance rather than on the basis of the fundamental requirements necessary to produce satisfactory illumination results. Less than three years after the remodeling had been completed the entire system was discarded in favor of a new one which combined both utilitarian value as well as good appearance. However, this time the primary requirements were that adequate and proper illumination would be provided, with good appearance a secondary consideration.

The existing lighting fixtures consisted of a decorated metal ring which fitted against the ceiling and which was equipped with six sockets, each having 40-watt round all-frosted lamps. The ceiling in this section is unusually low—7 ft.—and the glare that was produced by the exposed lamps was extremely annoying and uncomfortable to the occupants.

The fact that there was insufficient illumination was obvious to any one entering the bank. That the employees were aware of this fact was evidenced by a few larger size lamps which had been substituted for the 40-watt lamps. This did not materially boost the illumination and only aggravated the already serious glare condition. Investigation revealed that several employees were suffering from severe headaches and eyestrain.

Not only was every one concerned interested in improving the lighting conditions, but also in providing the most light for every dollar. It was, therefore, of some interest to determine the actual cost of light that was produced by the existing system as compared with that of a new system which produced illumination of a high quality.

The cost of light produced by each fixture was calculated. The round all-frosted lamps were rated as having an initial light output of approximately 389 lumens and an average life of 750 hours. The light output during the average life from one fixture of six lamps was 6×389 lumens $\times$ 750 hours $= 1{,}750{,}500$ lumen-hours. The energy consumed during this time was 6×40 watts $\times$ 750 hours $=$ 180 kilowatt-hours. The cost of this energy at an average rate of 5 cents per kilowatt-hour was $180 \times \$0.05 = \$9$. The cost of the lamps was \$0.35 list each, or \$2.10 for the six lamps.

Summarizing these figures will give the cost of light as produced by one fixture during the average life of the lamp:

Cost of energy	\$9.00
Cost of lamps	2.10
Total	\$11.10

A total of 1,750,500 lumen-hours of light was produced at a cost of \$11.10, or, in other words, 1,577 lumen-hours for one cent.

Semi-indirect lighting units employing one 300-watt lamp each were suggested to replace the existing fixtures. The cost of light was calculated for these units on the same basis as before.

The light output of the 300-watt lamp is 5,300 lumens and the average life of the lamp is rated at 1,000 hours. The total light output during the average life of the lamp is 5,300 lumens × 1,000 hours = 5,300,000 lumen-hours.

Since the lamp is inclosed in the glass globe, which is rated at 75 per cent efficiency, the actual light output is 3,975,000 lumen-hours. The energy consumed during this time is 300 watts × 1,000 hours = 300 kilowatt-hours. The cost of the energy is 300 kilowatt-hours × $0.05 = $15. The cost of the lamp is $1.25 list.

Summarizing these costs:

Cost of energy	$15.00
Cost of lamp	1.25
Total	$16.25

A total of 3,975,000 lumen-hours is produced in this case at a total cost of $16.25, or 2,446 lumen-hours for one cent. This is an increase of 55 per cent in light output over the old lighting fixture, which would be interesting even if no other improvement would result. However, the semi-indirect system reflecting a major portion of the light to the ceiling provides an apparent light source of large area, thus producing soft, well-diffused illumination with a minimum of shadows. The lighting units themselves are low in brightness, a welcome contrast to the extremely uncomfortable glare from the exposed lamps of the old fixtures. Foot-candle readings under the old system showed from 3 to 6 foot-candles. The new system delivers an average of 10 foot-candles.

Unit cost of light reduced

The larger lamps used in the new system are considerably more efficient than the smaller lamps and also have a longer average life, thus tending to decrease the unit cost of light. Ceilings were repainted white, which also assisted materially in increasing the resulting illumination on the desk tops. The greater uniformity of illumination is also a decided advantage as compared with that delivered by the old system.

With these facts and figures, it was not difficult to convince the bank's officials of the value in changing lighting equipment. Only the fixtures in the officers' space were replaced at first, but when they had been installed the improvement was so marked that all other departments were changed without solicitation on the part of the illuminating engineer. In fact, the employees working in the other areas were so emphatic in their request for similar improvement that a change to the new system throughout was imperative.

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Construction Costs at Fifteen-Mile Falls

Detailed construction costs of the initial or lower development of the New England Power Association system at Fifteen-Mile Falls were lately compiled by its engineering and accounting staff. A summary of the costs of this job is presented here, excluding the cost of the 220-kv. transmission line beyond the switching station, the cost of certain storage facilities far distant from the plant in the Upper Connecticut Lakes region and the cost of a low-head flow regulating station of 13,200 kva. total rating in four units at McIndoes, below Fifteen-Mile Falls.

The initial development, put in operation September 30, 1930, is on the Connecticut River in Monroe, N. H., and Barnet, Vt. It includes a combination earth embankment and concrete dam, concrete intake, overflow and spillway section, with concrete retaining walls and earth fills on each shore end. The pond (5,500 acre-ft. volume) extends about 7 miles upstream. The power house, of concrete, structural steel and brick, is located in the riverbed at the toe of the intake section of the dam. From the power house a tailrace excavated through rock and earth extends 6,600 ft. downstream. A spillway channel is provided to conduct water discharged through the sluiceways or over the spillway to the tailrace channel.

The lower development, now known as the Comerford plant, consists of four units, each rated at 54,200 hp. at 180 ft. head, generating at 13,800 volts. This energy is stepped up to 220 kv. for transmission to a substation at Tewksbury, Mass. Energy used for local distribution is stepped down from 220 kv. to 66 kv., 33 kv. and 2,300 volts.

The project required the excavation of about 1,180,000 cu.yd. of earth and 298,000 cu.yd. of rock. Of cofferdam cribs 39,000 cu.yd. were constructed, with 318,400 cu.yd. of embankment and the placing of 361,300 cu.yd. of concrete. As the nearest sizable town was 11 miles distant and because of the lack of good roads during the construction period, it was necessary to provide accommodations for about 70 per cent of the employees, or a village camp for about 1,780 persons. Maximum daily force, 2,486 men. Electrical energy for construction was distributed from a 4,000-kva. substation. Crushed rock and sand for concrete were obtained near the job. A diversion channel 1,500 ft. long, 25 ft. wide at the bottom and 40 ft. in maximum depth was excavated on the Vermont side. The initial development was made complete with four units.

Construction Costs for Power Development at Fifteen-Mile Falls*

(Cents omitted; four 39,000-kva. units complete design installed)

		Per Cent of Total		Per Kva.
Local general	$1,383,164	8.4		
Construction plant	1,150,351	7.0		
Preliminary work	740,400	4.5	23.6	$24.84
Diversion channel	465,066	2.9		
Operators' quarters	124,079	0.8		
Landscaping and cleaning up	11,454	0.07		
East retaining wall and earth fill dam	1,258,478	7.7		
Non-overflow and spillway sections	1,986,364	12.1	35.6	37.58
West retaining wall and earth fill	69,483	0.4		
Intake	1,728,617	10.5		
Tailrace	819,400	4.9		
Power house substructure	412,371	2.6	6.4	$6.66
Superstructure	625,980	3.8		
Equipment — hydraulic	606,779	3.7		
Indoor electrical	1,253,621	7.6	21.1	22.17
Step-up substation	1,598,151	9.8		
Interest during construction	993,553	6.0	13.3	14.09
Contractor's expense	1,206,013	7.3		
Total	$16,433,335			$105.34

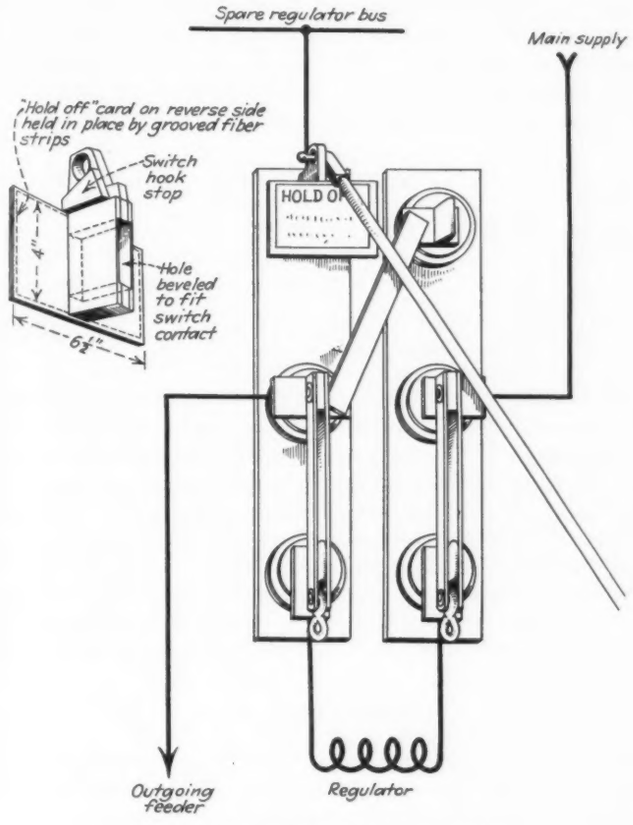
*Eight miles upstream is the site of the future upper development, having a capacity of the general order of the lower development. Certain features of the lower development contribute to convenience of the upper, but, in general, costs given are significant with respect to the lower development as defined in the text.

"Hold-Off" Cardholder for Use Near Live Equipment

By FRANK W. SULEWSKY
Assistant Chief Operator
Milwaukee Electric Railway & Light Company,
Milwaukee, Wis.

Need for a safe and convenient method of affixing "hold-off" cards to 4,000-volt regulator transfer switches in the close proximity of live conductors brought about the adoption of a fiber cardholder by the station operation division of the Milwaukee Electric Railway & Light Company. This holder was designed to take the place of any makeshift methods which might have been in use when necessary to work on equipment without taking the entire circuit out of the service.

By referring to the accompanying sketch, it is evident that the circuit may be alive by closing disconnecting switches to the so-called transfer bus. The "hold-off" card used in this special holder in no way takes the place of the usual "hold-off" card placed on the control switch or operating handle of the oil circuit breaker in the particular circuit being worked upon; however, with the connections used for by-passing feeder regulators, cards placed in the usual locations do not offer sufficient protection.



Hold-off card in blocking device

The "hold-off" cardholder is made up of fiber as shown in the sketch. The front is constructed so that the "hold-off" card can be inserted readily and can be observed when placed on a circuit. So that additional equipment would not have to be provided in the stations to put on the holder, the hole and stop were designed to fit a standard square micarta switch hook head. The opening which fits over the clip of the transfer switch is tapered so that the holder may be fitted firmly in place and will not fall off when bumped accidentally.

The operation of the holder is very simple. To affix a "hold off" the card is made out and inserted in the holder. The switch hook is then inserted in the hole of the holder and held against the stop. The holder is pushed back onto the clip of the open switch and the switch hook is then removed. The "hold-off" card with the holder is left there, as shown in the accompanying sketch, until the job is completed. This protects the workmen by showing the "hold-off" card plainly and as an added safeguard prevents accidental closing of the switch, either by falling in or by an operator making an error in switching.

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More on Home-Maker's Attitude

In a recent survey of homes, reported in the December 31, 1932, issue of ELECTRICAL WORLD, more than half of the women declared that homes of some of their neighbors could be made more attractive by improving the lighting. The value of better lighting was appreciated more (66 per cent) by the upper class. As might be expected, natural lighting was preferred for most close work, but 7 per cent expressed a preference for artificial light for certain kinds of close work. Daylight was considered best for the following operations by the percentage indicated: Sewing (48 per cent), reading (19 per cent), writing (6 per cent), housework (6 per cent), office work (7 per cent), everything (21 per cent).

Relation of Electric Lighting to Natural Light and Favorite Room

(L = Low class; H = high class; A = all classes.
Figures show per cent of homemakers expressing this opinion.)

	Best Natural Lighting			Favorite Furnishings			Electric Lighting: Best			Electric Lighting: Poorest		
	L	A	H	L	A	H	L	A	H	L	A	H
	Per Cent			Per Cent			Per Cent			Per Cent		
Living room	29	23	23	68	74	78	51	57	66	13	9	8
Dining room	13	12	11	8	7	4	17	10	4	3	5	7
Kitchen	28	16	7	6	4	3	19	12	5	8	5	2
Bedroom	16	19	18	8	6	..	3	4	3	22	17	14
Bathroom	1	1	..	..	..	..	1	1	..	2	2	..
Sunroom	4	14	22	4	4	5	1	2	4	..	2	2

Attitude on needed improvement		Yes	No
		Per Cent	
Economic Class	Low	7	45
	Medium	2	57
	High	4	62

Nearly 60 per cent recognized eye strain was being caused by improper lighting, but 37 per cent did so only after it was pointed out. Carelessness in use of light was admitted in 26 per cent of the homes. In these the home maker, herself, admitted the greatest carelessness (28 per cent), sons, nephews (25 per cent), children (25 per cent), daughters (19 per cent), husbands (14 per cent).

Decorative lighting is used at Christmas by 71 per cent of the families; 59 per cent for inside trees, but more light trees both inside and outdoors than just outside alone. The latter is not a substitute but a supplement to the inside tree. Eight per cent keep some light or lights burning all night.

Lamp Flicker Traced to Critical Compressor Resonance

AGREEMENT between compressor producers and electrical manufacturers and utilities on a 66 per cent motor-current fluctuation has in general worked out well. The standard appears to be fundamentally sound and correct. For metropolitan circuits, where current variations occasioned by refrigerator compressor loads are a minor part of the total load, the results have generally borne out the wisdom and adequacy of the standard. Not all the loads can be confined, however, to the areas where circuits are ample. With the advent of air conditioning it is likely that cases will increasingly arise where adoption of standard equipment conforming to the rule may not succeed in avoiding flickers especially for certain critical frequencies of the pulsations of current.

Possibly both manufacturers and utilities may have to accommodate to one another the factors which determine the economic balance of design, in motor-compressor units on the one hand and in distribution circuits on the other. That applies to the day when air conditioning fulfills the dreams held for it as an expansive movement spreading widely over utility distribution circuits. Isolated instances have been experienced with installations of direct-connected, two-cylinder, single-acting compressor units driven by motors in the 257 to 300 r.p.m. speed range, a relatively recent development. Two of them are detailed here to show the correlation of the quantities involved.

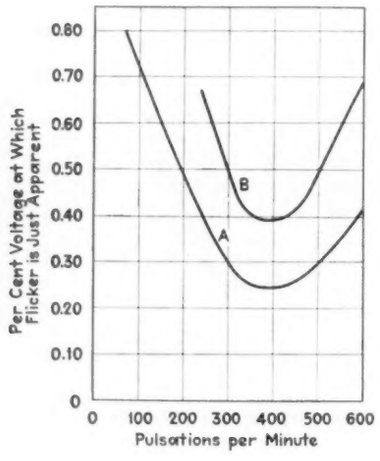

Fig. 1—Flicker most noticeable at 6 to 7 per second

(A) G.E. tests on 60-watt "Mazda" B and 100-watt "Mazda" C 115-volt lamps.

(B) Utility tests under less ideal conditions of wall color, reflections, etc., than in A.

As for the critical aspects of the flicker phenomenon, studies conducted several years ago by the General Electric Company showed a 0.25-volt sensitiveness at 400 cycles per minute (see Fig. 1). Other studies, made under less ideal conditions of color and reflectivity of the surroundings, have shown a voltage variation of 0.40 volt as that at which flicker of just perceptible magnitude is established. The speed trend toward values in the 257–300 range coincides very closely, therefore, with the region of maximum flicker sensitivity of the eye, because in most instances the flicker per minute is double the operating speed in r.p.m.

Resonance is the crux of the problem

The whole question is one of resonant mechanical frequency for the electromechanical combination of motor and compressor. If the natural beat effect of the compression stroke in the compressor approaches the natural resonant frequency of the motor oscillation its torque and current will vary at this frequency in the effort to hold synchronism. As usual in such cases, the factors which can be called into play to correct the adverse condition are those which have contributed most to creating it. A formula, presented by R. C. Allen in *Power* for January 26, 1932, embraces these factors:

$$F = \frac{266.500}{\text{r.p.m.}} \sqrt{\frac{P_s f}{WR^2}}$$

where

F = resonant frequency of the motor system in beats per minute.
P_s = motor design constant, in kilowatts output per electrical degree displacement of the rotor.
f = electrical frequency (60 cycles).
WR^2 = flywheel effect of motor rotor, flywheel, if any, and compressor.

The natural beat coming from the compression cycle of the compressor will equal the revolutions per minute for a single-cylinder, single-acting compressor, will be twice the revolutions per minute for a two-cylinder, single-acting compressor, etc. With a two-stage, two-cylinder compressor or a two-cylinder, single-stage compressor there are important beats that equal the revolutions per minute or are four times the revolutions per minute.

Evidently the principal source of relief in the compressor area does not rest alone on multi-cylinder or multi-stage design unless the speeds for most economical size and cost fall well below or well above the range of critical flicker frequency. Of course the centrifugal compressor escapes practically all of the flicker hazards.

Effect of adding inertia

Speed increase coming with the adoption of the smaller direct-connected motor drives in place of the former engine drives has been a factor in bringing the resonant frequency of motor and compressor into the region of maximum flicker sensitivity. The second factor is the rotational inertia of the motor rotor, the compressor crankshaft and the flywheel, if any. This must evidently be considered in conjunction with the motor design constant, P_s, and the effect of inertia upon the starting current. Adding flywheel rings to the rotor tends to lower the resonant frequency, but increase in pull-in torque per degree of rotor swing from syn-

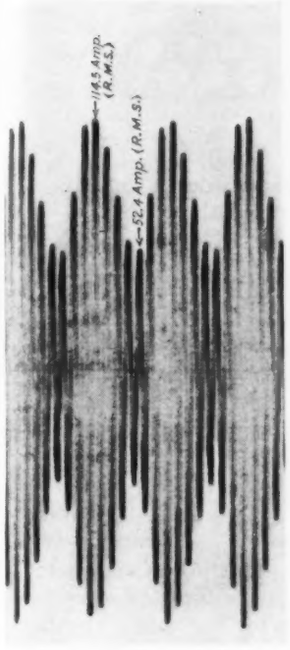

Fig. 2—257-r.p.m., 100-hp. unit gives 1.74 per cent flicker at 8.5 c.p.s.

This is three to five times the minimum detectable value from Fig. 1.

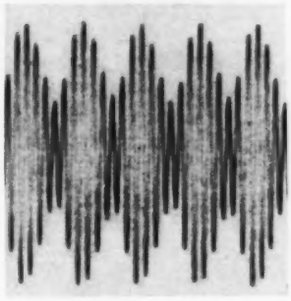

Fig. 3—300-r.p.m., 100-hp. unit gives 1.29 per cent flicker at 10 c.p.s.

This is two to three times the lowest value noticeable at this frequency.

chronism tends to raise the frequency. The balance of these two items in conjunction with the speed adopted will determine whether the resonant frequency of the rotor system will fall below or above the area of maximum flicker sensitivity. The speed adopted in connection with the number of stages and cylinders will meanwhile have fixed a particular value of compression frequency.

Manifestly these electrical and mechanical frequencies should not be close to one another in value. If both fall in the region of maximum flicker sensitivity the worst may be expected. There would be some virtue, therefore, in aiming to have them straddle the 400-cycle point of most critical behavior for installations on light distribution lines. In the final analysis it is a case of composite adjustment of (1) impedance in the supply circuit, (2) magnitude of current fluctuation at the motor and (3) frequency of the fluctuations, especially if they fall between 250 and 500 per minute.

Two cases in detail

To make the point specific, two instances reported by an Eastern utility may be cited. In both instances the flicker was objectionable and detrimental to service. In one, an ice-making plant, a two-cylinder compressor was driven by a 100-hp., three-phase, 60-cycle synchronous motor direct connected at 257 r.p.m. The line voltage was 4,600 and motor voltage 440.

The motor rating at this voltage was 108 amp. Current fluctuation was guaranteed not to exceed 66 per cent or 71.3 amp. Tests indicated that the performance was up to specifications.

The 4,600-volt circuit, which is approximately 5 miles long and has fairly light copper, gave a voltage drop of 0.028 per cent per ampere of 440-volt load. With full load on the motor the voltage variation would be 71.3 amp. times 0.028 per cent or a total voltage variation of 2 per cent. At the time the oscillograph record (Fig. 2) was taken the motor was running at less than full load, the ammeter indicating 88.5 amp. The maximum and minimum currents revealed by the oscillogram were 114.5 and 52.4 amp. respectively, giving a difference of 62.1 amp. The voltage variation computed was 1.74 per cent.

The second troublesome case involved a 100-hp., three-phase, 60-cycle synchronous motor of 300 r.p.m. direct connected to a two-cylinder compressor. The motor operated at line voltage of 2,300. The same guarantee of 66 per cent current variation applied. The nameplate rating of the motor was 21.6 amp. In this case the circuit was only 1.2 miles long, but the lower voltage offset the larger size of copper. This circuit gives a voltage variation of approximately 0.11 per cent per ampere of 2,300-volt load current. At full load this represents 1.57 per cent. At the time the oscillogram of Fig. 3 was taken the load was less than full load and resulted in a voltage variation of 1.29 per cent.

Fluctuations of 1.29 and 1.74 per cent seem low and permissible. They might be if they occurred at the system frequency. But occurring at the frequency at which the eye is keenest at sensing its existence such a flicker voltage is ruinous to customer good will. In these two cases any corrective which would effect a reduction in current variation to lesser percentage would have a correspondingly helpful effect on varying voltage drop and flicker. For 40 and 20 per cent of current fluctuation the results would be:

Current Variation Per Cent	Voltage Variation	
	Case 1 Per Cent	Case 2 Per Cent
40	1.21	0.61
20	0.95	0.48

Admittedly the resort to more inertia might indirectly tend to increase the starting current, and this in turn might necessitate special starting equipment to keep the current inrush within bounds. It must be remembered, however, that the low-frequency flicker is a continuing phenomenon when the equipment is operating, whereas the dip at starting is intermittent, with fairly long intervals generally occurring between the happenings. It is also admitted that most of the more recently installed two-cylinder compressors are operating without complaint, even though the speeds range from 250 to 400 revolutions per minute.

Some cases which have led to voltage flicker have been traced to defective equipment which abnormally increased the load on the motor.

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Economical Underground Ducts

By J. H. WILSON

A simple and economical method of installing the control leads from an outdoor switching station to the control room in the transformer building has been successfully used by the Aluminum Company of Canada at its Arvida works.

A shallow trench about 2 to 3 ft. in depth is dug, wide enough to accommodate the conduits required. In the bottom of this a layer of asphalt roofing is laid, with its sides lying flat along the sides of the trench. The conduits are put in on top of this. Hot tar is then applied liberally with a brush, so that no exposed metal is left bare. More tar is poured in and one side of the roofing

felt is folded over the top to make a snug fit. The upper surface is again liberally brushed with tar, the other edge folded down and more tar applied. The result is that when the tar cools the conduits are inclosed in a flexible, semi-plastic coating of tar, which is held in place by the impervious roofing felt.

The flexibility of the tar coating keeps the conduits protected from air or moisture in spite of the heaving caused by frost due to the shallow trench. A fairly generous initial slope for drainage is allowed to compensate for any throwing out of line due to this.

This system of installing conduits was found to be so cheap that provision for future extensions may be cut to the absolute minimum. It is found to be cheaper to install conduits in this manner as required rather than to put too many spares in the original installation.

Conduits put in as described above were installed at Arvida about seven years ago and no trouble has yet developed with them. A modification of the method was used in a recent extension, where an underground tunnel to carry cooling water and oil lines carried the control cables on racks as well. The runs from this tunnel to the individual circuit breakers, potential transformers, etc., were taken off near the top of the tunnel and laid in shallow trenches as described.

Roofing felt forms envelope around conduits coated and covered with tar

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READERS' FORUM

Surge-Proofing Preferable to Surge Absorption

To the Editor of the ELECTRICAL WORLD:

Your issue of February 11 presents an editorial article on the subject "Shunt or Insulate Transformers," purporting to give views of an impartially interested observer on the matter of protecting transformers against surges.

American engineers are not likely to consider seriously surge absorbers until they learn the facts about them, and when they do surge absorbers will go the way of choke coils—and for the same reason—because they perform no useful function.

The transformer subcommittee of the A.I.E.E., of which I happen to be chairman this year, has sponsored during the last several years a large number of scientific papers on the general subject of protecting transformers against surges. The views that were expressed in this article are contrary to the fundamental principles established in these various papers and must therefore be challenged.

The inference is made that we do not know with certainty the voltage stresses at all points in our transformer windings resulting from the surges which can reach the transformers. We do, and we know also that these stresses are well within the insulation strength at every point. The statement is made that the practice of reinforcing the insulation of the end turns of windings is no longer to be depended on. Not so; reinforced end turns will continue, particularly in the medium-voltage classes; refinements will be found in the higher-voltage classes. It is stated that commercial surge testing is hazardous and operators should look upon it with trembling for fear some undetected damage will be done. The transformer subcommittee has placed its stamp of approval on commercial impulse testing. It is on a sound, scientific basis. Failures can be detected, and operating engineers who are most familiar with it are its most ardent supporters.

The statement "If such a surge absorber could be made immune from the disruptive effect of steep wave fronts and could function on sloping wave fronts we might be pointed along the road toward eventual safeguarding of transformer windings" is worthy of comment. Effective safeguarding of transformer windings is not something we are looking forward to. It has been an accomplished fact for a considerable time and quite independent of surge absorbers. But can surge absorbers, which involve bushings, windings and insulation, be made more immune to surges than transformers? No, they involve the same design problems, so it is logical to build the protection into the transformer directly.

Finally, the inference is made that surge-proof transformers are inherently expensive. Actually, surge-proof power transformers cost not one penny more, and that being the case, no one is likely to buy a non-surge-proof transformer. And having bought a surge-proof transformer with a guaranteed and demonstrated impulse strength, additional expenditure for a surge absorber would appear to be unwarranted, particularly since such a device cannot give added protection to the transformer.

The principle of the surge absorber is simple but unsound. It merely slopes off the front of the wave, but does not appreciably alter its magnitude. Reducing the steepness of the front is supposed to make the surge innocuous—it is assumed that the magnitude does not matter. Yet just the opposite was shown to be the truth at the winter convention of the A.I.E.E. The time lag curve of insulation was found to be flat clear down to 2 microseconds. In other words, regardless of the duration of the surge, failure would take place above a given magnitude, but not below it.

It is suggested that engineers should experiment with surge absorbers. Had I a suitable surge absorber I would be glad to make publicly a simple demonstration to show that it cannot protect a transformer. I would build a good-sized insulation or transformer model having an impulse strength to ground of perhaps 1,000,000 volts. The absorber should have bushings with a flashover of perhaps 1,500,000 volts, because I would not want them to flash over and act like a co-ordinating gap. I would adjust the surge generator to give a 1½–40 wave with the transformer connected. The surge absorber would then be connected in the circuit and a surge of perhaps 1,300,000 volts applied. The front of the surge might be sloped off to 3 or 4 microsec-

onds, but failure would be inevitable because the magnitude of the surge would be greater than the dielectric strength of the insulation to ground. Repeating the experiment with a duplicate model and a lightning arrester would indicate the protective ability of the arrester because it operates on the sound principle of limiting the magnitude of the surge.

It may be argued that reducing the steepness of the front of the surge will reduce the stresses between turns and coils. But substantially the same stresses result from an immediate collapse of the surge voltage, in the case of a gap or bushing flashover, as result from a steep applied front, and with nothing to limit the magnitude of the surges, bushing flashovers would occur. In any case, the scientifically designed transformer will have just as high insulation strength within the winding as to ground. But even if it didn't, and even if there were no bushing flashover (due perhaps to oversize bushings), there would be no purpose in reducing the stress within the winding, only to have a major breakdown to ground.

American engineers are not likely to be misled in regard to surge absorbers. They have learned much in recent years about the characteristics of transformer windings when subjected to surge voltages. They will insist on an unrefutable demonstration of their worth and economic justification.

H. V. PUTMAN,
Engineering Manager.
Westinghouse Electric & Manufacturing Company,
Sharon, Pa.

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BOOK REVIEWS

Public Utility Regulation

By W. E. Mosher and F. G. Crawford. Published by Harper & Brothers, 49 East 33d Street, New York, N. Y. 612 pages. Price, $5.

"If regulation does not keep pace with the operations of these vast enterprises the people of the country may unexpectedly find that the utilities, which, according to law, tradition and reason, should be the servants in the house, have become its masters." Thus do the authors subscribe to the "public defender" concept of regulation in their exhaustive search for functions not now satisfactorily performed by the commissions. Understaffed, underpaid, inexperienced boards are allowed a personnel of only 1,624 and $7,000,000 in funds to regulate enterprises collecting nearly $5,000,000,000 annually. Twice as much outlay and several times as much activity are needed even though "any regulation worthy the name" is bound to "interfere with management."

Valuation on a reproduction appraisal basis is caustically condemned as "one of the most unreal fields of speculation in which the minds of metaphysicians have disported themselves since the days of the medieval schoolmen." Nor is the "higgling" procedure of value and rate negotiation viewed with favor. As for rate of return, "we have not permitted reasonable returns on reasonable investments, but exorbitant returns on the amounts invested by common-stock holders." The cost-plus basis of rate making is strongly advocated, along with the plea that the maximum-service motive should supplant the maximum-profit motive. In the field of the holding company and the interstate problems the establishment of "joint boards acting under and with a central federal agency" is the solution offered.

Rural electrification is posed as the major criterion of the success of regulation and of the avowedly social character of the electrical industry. Likewise, more freedom for municipal utilities is put forward as an automatic competitive adjunct to private utility regulation. "The sole justification for private management and operation is that this policy will result in lower rates and better service. When it has once been demonstrated that these expectations are not realized, the only and the accepted alternative is public operation."

Something like two-thirds of this comprehensive and well-documented analysis of the current effectiveness of regulation is devoted to the electrical industry. Opinions on the correctives are freely and potently expressed, but by no means are they of a perverse or demagogic nature; many of them are fortified by citation of the Supreme Court dissenters, leaders of the industry and of ELECTRICAL WORLD articles and editorials. The book deals with regulation as a working institution and not as a theory. Precedents are drawn in, but they are subordinated to the vexing dilemmas which make utility regulation one of the most commanding problems for talented administration that exists in today's social-economic welter.

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Problems in Public Utility Economics and Management

By C. O. Ruggles. Published by the McGraw-Hill Book Company, 330 West 42d Street, New York, N. Y. 737 pages, illustrated. Price, $6.

Harvard's Professor Ruggles has here taken utility management problems out of the realm of opinionation and of mere legal precedence by setting up a wide range of such problems on a case basis. About one-third of the 120 cases are cognate to commission and court proceedings; the others are management problems out of the author's field experience. Thirty-one have to do with electric power utilities; others are devoted to telephone, street railway, gas, bus, etc. The material is so selected and arranged as to pose the essence of each case from the angle at which the utility operator would have to view it. Not only are the cases distributed over the whole utility field but they also reflect such diversity as would fall under the heads of production, organization and finance, wholesale and retail marketing of utility services, valuation, rate-making and regulation on such additional items as contracts, mergers, holding company relations, etc.

The cases are real. In presenting them the stress is not on the legal side, but on the dollar and social elements. No answers are given to any of the problems nor is the subject matter twisted to support any particular answer. Utility people as well as college students should find in this book a factual foundation for provocative thought on what management can do and can avoid doing to affect relations with its regulatory masters and its touchy public.

Men of the Industry

General Electric Engineers Receive Coffin Awards

CHARLES J. THOMSON, construction foreman of the General Electric Company, has been awarded a citation and an honorarium by the Charles A. Coffin Foundation for his achievement on the Dnieprostroy installation. While in Russia, where he supervised the erection of huge waterwheel generators on the Dnieprostroy hydro-electric project, the Soviet government conferred on Mr. Thomson the Order of the Red Banner of Labor in recognition of his services. Prominent among the other Coffin award recipients are Dr. SANFORD A. Moss of Lynn, Mass., who designed and introduced the centrifugal supercharger, or "tamed tornado," which reinforces airplane engines, and HERBERT D. BROWN of Schenectady, who developed the mercury-arc rectifier, useful in railroad electrification. Other awards were made to GEORGE B. SHANKLIN, engineer, who developed the present practice in high-voltage, oil-filled underground electric cable, used in various localities up to a maximum of 132,000 volts; to ERNEST L. ROBINSON and WALTER C. HECKMAN, engineers, who discovered the reason for failures in medium-sized buckets of steam turbines and worked out a method of design which overcame these failures, and to Gwilym F. Prideaux, engineer in the incandescent lamp department at Cleveland, who developed an electric lamp for use while taking indoor movies and photographs.

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CHESTER F. BUCKLEY, formerly assistant manager, has been appointed manager of the Taunton, Mass., municipal electric light plant, succeeding the late George F. Seibel.

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A. M. SNODGRASS has been appointed production manager of the Pittsfield, Mass., works of the General Electric Company. In the employ of the company twenty years, Mr. Snodgrass was formerly superintendent of the meter department at Fort Wayne, Ind., and more recently he was production manager of the West Lynn, Mass., works.

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CLYDE A. BYRD, formerly manager of the Florida Power & Light Company at Sanford, has been appointed general manager of the Daytona Beach division of the company. Mr. Byrd is a native of Florida and a graduate of the Georgia Institute of Technology. He had been stationed in Arcadia for several years before affiliating himself with the Southern Utilities Company in Sanford in 1924. This property later was taken over by the Florida Power & Light Company.

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FRANCIS BLOSSOM, of Sanderson & Porter, and FARLEY OSGOOD, consulting engineer, have been designated by the American Engineering Council as its representatives on the National Trade Recovery Committee.

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MERRILL G. BAKER, formerly assistant to the vice-president of Ford, Bacon & Davis, Inc., consulting engineers of New York, has been elected president of the Union Steel Casting Company of Pittsburgh.

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C. F. BOYNTON, formerly chief inspector of the Department of Water Supply, Gas and Electricity for New York City and later district sales manager for National Electric Products Corporation of Pittsburgh, with headquarters in New York, is now connected with the National Electrical Manufacturers' Association as assistant to H. B. Kirkland on uniform legislation activities.

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A. D. PEABODY, formerly division manager of the Westinghouse Electric Supply Company of Texas and Oklahoma, has been appointed district merchandising manager of the Westinghouse Electric & Manufacturing Company, East Pittsburgh. A graduate of the Carnegie Institute of Technology, Mr. Peabody has been associated with the electrical industry since 1907, when he joined the staff of the Westinghouse company at East Pittsburgh. Later he went in business for himself, forming the Peabody Electric Company in Oklahoma, but the organization was purchased by Westinghouse Electric Supply in 1928 and Mr. Peabody was appointed manager for the states of Texas and Oklahoma.

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H. F. LEHMAN, since 1928 service manager of Frigidaire Corporation, has been appointed commercial sales manager of that organization, to succeed Lowell McCutcheon, who was recently placed in charge of the company's Chicago operations. Mr. Lehman entered the employ of Frigidaire during vacations, while a student at Otterbein College, and upon graduation was assigned to the final inspection department. Transferred to the service department, he became assistant service manager in 1926 and two years later was appointed service manager. H. S. TURNER, formerly assistant service manager, succeeds Mr. Lehman as head of that department. As commercial sales manager Mr. Lehman will have supervision of all of Frigidaire's commercial sales activities.

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WILLIAM HART of Benton, Ill., has been appointed secretary of the Illinois Commerce Commission by Governor Horner to succeed Julius Johnson.

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PERRY MCCART of Paoli has been elected chairman of the Indiana Public Service Commission. Mr. McCart is a native of Paoli and a graduate of the University of Tennessee. He was for a time attorney for the Chicago, Indianapolis & Louisville Railroad and subsequently its general counsel.

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OBITUARY

STANLEY C. WEBB, president and general manager of the Webb Electric Company, St. John, N. B., died February 18, in the General Hospital in that city, after a two months' illness. Following graduation from the University of New Brunswick, Mr. Webb joined his father, a pioneer electrical engineer and contractor, in the electrical business at St. John. After his father retired, about ten years ago, Mr. Webb became president and general manager of the company and during his tenure of office had widened the scope of the business to include the sales of all kinds of electric appliances.

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WILLIAM W. BLUNT of Port Huron, Mich., formerly connected with the Westinghouse interests in this country and abroad, died February 25 at Preston Springs, Ont., in his sixty-fourth year. Following graduation from Lehigh University in 1891, Mr. Blunt joined the Westinghouse Electric & Manufacturing Company. Later he was made a member of the international commission which went to Peru to survey prospects for an electric railroad across the Andes and on the completion of that undertaking he reported on the electrification of the Lima tramways. In 1896 Mr. Blunt was appointed assistant sales manager in New York by the Westinghouse company, but four months later was sent to London as its chief engineer in the British Isles, serving until 1899, when he was named engineer of the British Westinghouse Electric & Manufacturing Company, of which he subsequently became assistant manager and in 1906 one of the two general managers. Mr. Blunt remained with the British company until 1919, when he transferred his interests to Port Huron, Mich., where he became sales manager and later secretary-treasurer of the Holmes Foundry Company.